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REPORT OF THE ZOOLOGIST.

This report is substituted for the usual report by Prof. Bruner on Insect Parasites.

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THE PARASITIC WORMS OF MAN AND THE DOMESTIC ANIMALS

By Henry B. Ward, Ph.D., University of Nebraska.

PART I.—GENERAL

This article has been written for the general information of those engaged either on a large or on a small scale in stock raising in our own state particularly, and, while not intended to be a complete treatise on the subject, it includes references to those parasites which seem to be the most important or most likely to be found within our borders. The parasites of cattle, sheep, horse, hog, dog, cat, and man, which have many species in common, form the subject of this paper. The parasites of domestic fowl are, however, quite different from those considered here and are omitted in the expectation that it may be possible soon to treat them in a special article.

All scientific work at present is recorded in the metric system, and the amount of labor necessary to reduce the measurements given in various books of reference to the English system was so great that it seemed best to reproduce the measurements here in metric units and add a table by which those who wished could change them when necessary. The growing use of the metric system in our own country and the ease in manipulation afforded by it arouse the hope that it may soon be the prevalent system even outside of scientific circles.

MEASURES OF LENGTH.

1 meter, written 1 m. = 39.37 inches, nearly \( \frac{10}{3} \) yards.
1 decimeter, written 1 dm. = 3.937 inches, nearly 4 inches.
1 centimeter, written 1 cm. = 0.3937 inches, nearly \( \frac{1}{2} \) inch.
1 millimeter, written 1 mm. = 0.0394 inches, nearly \( \frac{1}{25} \) inch.

In addition to the older works of Diesing, Dujardin, Leidy, Davaine, Cobbold, and others, reference has been made to many recent papers of Blanchard, Braun, Curtice, Francis, Leuckart, Neumann, Railliet, Stiles, Welch, and Zschokke. It is of course impossible to recognize here in detail my indebtedness to these writers. I append, however, a short list of the more extended works which have the closest relation to the entire subject or to which the American is most likely to refer. To all of these I am indebted.
for numerous details and figures. For the latter acknowledgement is made in each case.

Braun, M.

Vermes, in Bronn's Classes and Orders of the Animal Kingdom. (German). Incomplete as yet. Leipzig.

Leuckart, R.

The Parasites of Man and the Diseases Induced by Them. 2d Edition. Leipzig 1879-1895. (German.) Not yet finished.


Neumann, L. G.

Treatise on the Parasites and Parasitic Diseases of the Domesticated Animals. Paris 1888. (French.)

English Translation by Flemming. London and New York 1892.

Railliet, A.


Stiles, C. W.

Revision of the Adult Cestodes of Cattle, Sheep, and Allied Animals U. S. Department Agriculture 1894.

Verrill, A. E.


Appendix to same; Report Connecticut Board 1871.

In the belief of the medical profession two hundred years ago there was no disease, real or imaginary, which was not due to the presence and effect of some kind of parasite. Each ailment had its particular "worm" in its characteristic location. This was a direct result of the endeavor to reduce every malady to some definite cause, and from the joining of the unknown sickness with the parasites of which they knew as little. Under the influence of study and of our increasing knowledge of the parasites such a theory was seen to be untenable, and the movement in the opposite direction began—a tendency which may be said to have reached or by this time to have passed its height. Recognizing gradually, though certainly, the absurdity of regarding parasites as the cause of all diseases, the world came to consider them as entirely harmless, as objects which could be left out of account in practical questions. To this is due more than to any other single factor the neglect of study in the direction of the economic importance of parasitic animals; for, while a long list of famous zoologists has devoted best efforts to this work, it is none the less true that the subject as a whole has not received the attention which, for instance, has been devoted to the study of parasitic plants. The extended observations of botanists in many agricultural experiment stations has accumulated a mass of practical knowledge for the farmer which enables him to guard against the attacks of dangerous fungi, or to cope with the various diseases caused by them, with some chance of success. In his fight with insect enemies the farmer is even better instructed. Varied and extensive publications enable him to identify his unwelcome guests and to make use of the best
possible means for getting rid of the particular species with which he has to do. How different the case is with regard to the internal parasites. Of their nature, their abundance, their complicated life-history he knows almost nothing; of the damage they may do, of the trouble they are causing, of the means to fight them he is equally ignorant; that it is possible to prevent their occurrence has never been suggested to him. This lack of definite, useful knowledge on so important a subject is not his alone; it is so widespread as to give rise to a deep-seated opinion, even among some veterinarians and similar instructors to whom the farmer looks for assistance, that, except in the rare instances when they become epidemic, parasites are harmless necessities, to be endured rather than to be cured. The possibility of avoiding them, the doctrine of prevention, has never been rationally and forcibly presented to the attention of those who are most deeply and personally interested in it. I can account for this on no other possible grounds than the opinion, inherited from past neglect, that the presence of parasites in stock has no appreciable effect upon its value. That this is not true I think can be satisfactorily shown, and that for the best results, financially and otherwise, stock must be kept free from parasites seems to me equally clear. In spite of the neglect of this line of study, there are still some valuable suggestions which deserve wide publicity, and which will serve as a basis for future work. It is my object in this first article to outline such general matters and to give such hints as may be safely given on general grounds, hoping that the future may make it possible to conduct extended studies into the presence and frequency of parasites in our state, and to determine the best means of fighting them in each special case.

A parasite may be generally defined as any organism which obtains shelter and nourishment from some living thing. It is evident, then, that plant as well as animal may live parasitically, and two groups, the plant parasites or phytoparasites, and the animal parasites or zooparasites, may be readily distinguished. Again, it is easy to recognize among animal parasites, which especially concern us here, a subdivision according to manner of life into those forms which live on the outside, the external or ectoparasites, and on the other hand the internal or endoparasites, those which pass a large part or the whole of their life within the body of some other organism. It is a curious fact that the endoparasites, with one or two uncommon exceptions, fall within the group of animals known to zoologists as the worms. Much less highly developed than the common earth worms, they constitute the lowest subdivisions of the branch and form a small number of well marked classes which will be considered later in some detail.

The number of recorded parasites is now not less than ten thousand. Some are very rare, some are inhabitants of far distant countries, others live in our midst but inhabit forms which are only indirectly connected with the purpose of this study, and while they are interesting as well as important in one sense they can hardly be considered in the limits of this
paper. As a general principle governing the selection of special forms, it may be said that any parasite is of economic importance when at any time in its life it draws nourishment or support from

(1) **Man.**

(2) **Any animal**

(a) **furnishing him with food,** such as cattle,

(b) **valuable to him as a pet,** such as dog, cat,

(c) **useful to him in labor,** such as horse, mule,

(3) **Any food plant**

(a) **of man,**

(b) **of the domestic animals.**

While this in general is the field of economic helminthology, as the study of internal zooparasites is called, it is true that in the beginning its attention must be chiefly directed towards those domestic animals which are most important and which from their manner of life in herds or in confined places are most liable to be seriously affected by parasites. With these the parasites of man himself are so intimately connected that any separation is impossible, even if it were desirable, since he both receives from them and gives to them. At the same time the parasites of man’s two closest pets, the cat and dog, are in many instances those which are also at home in the human system, and his intimate association with these pets renders infection easy and a knowledge of the parasites concerned peculiarly advisable. Viewing the subject, then, from the more restricted standpoint outlined in these last statements, this article will deal especially with the internal parasites of man, cattle, horse, sheep, hog, dog, and cat. Lists are given showing the species which at present are known to inhabit these animals, and, so far as possible, those species which have already been discovered in this country are starred. These lists are preceded by a general description of each class of parasites and a particular account of some of the more common or more dangerous forms.

It is true that internal parasites are very widely distributed, and that scarcely any animal is entirely free from them. They are, however, usually present in limited numbers, and are believed to be harmless if infrequent or of small size. This does not seem to be strictly correct, for while it is doubtless true that the effect of a single parasite, or even of a considerable number of minute size, is small and difficult to measure or estimate, it is equally clear that even this is a certain drain on the domestic economy of the host, as that animal is called which furnishes to the parasites their shelter and food. Furthermore, the tax on the host is exactly in proportion to the number and size of its unbidden guests. This will be perfectly clear if we take account of the various ways in which a parasite draws from the host. Here we shall see a difference whether the parasite is active and growing in the alimentary canal or some other cavity in the body of the host or passively resting in the midst of the tissue of some organ.
In the first case the draft on the host is much the greatest and manifests itself in three ways. The parasite requires a certain amount of food for its support; this it takes directly from the host, either from that which the latter has digested for its own use, if the parasite be in the alimentary canal, or from material which the host has formed to perform certain work, as in the case of blood parasites, or from the tissue of the host, as some intestinal worms which feed on the cells composing the wall of the intestine. In any case the host expends the extra energy necessary to procure and digest the food taken by the parasite, and this extra labor will be directly in proportion to the amount of food taken, or in general to the size of the parasite and the number of eggs it lays, that is its fertility.

In the second place the parasite occupies a certain amount of space and reduces the calibre of the tube in which it lives by so much. Unless a considerable number are present this is hardly a practical stoppage for the alimentary canal, but in the case of the blood system a vessel may be closed or a clot formed by the presence of even a very few parasites.

Finally, in the third place, active parasites will, by their movements, give rise to a certain amount of irritation and inflammation of the membranes over which they move. This is in some ways, perhaps, the most serious trouble which a few parasites can cause, and it is much increased if in the special case the parasite obtains its food at the expense of the tissues of the host, that is, if it tears or consumes the walls of the cavity in which it lives. A secondary, though possible, result of this manner of living is the liability of rupturing some blood vessel, and the consequent loss of blood, if not loss of life, by the host. This is the case especially with certain lung flukes which make inroads upon the tissue of the lungs, and thus weaken those important organs of the host. In the course of their work in the lung tissues, however, they may chance upon some large blood vessels, and in this way produce even fatal hemorrhage. It is evident, then, that no more than a single active parasite may be dangerous and that it is always some tax on the domestic economy of its host. Of course the effect of a microscopic worm in the alimentary canal of an elephant will be so small that it could hardly be calculated in any way; but we should be careful not to extend this reasoning too far. The physician knows that the disturbance produced in the human system by a single tape-worm is sufficient to call for prompt measures to remove it, and any one who has witnessed the slaughtering of cattle, sheep, or hogs, knows that often the average number of parasites is greater than this in proportion to the size of the animal.

Considering, then, what has just been explained—that the draft of the parasite is proportional to their number and size—it is, I think, clear that the average number of parasites in domestic animals means a considerable draft on the energy of the host, a tax which, were the parasites absent, would be expressed in so much marketable flesh, to say nothing of the more healthy general tone of the stock, and hence its power to resist extremes of temperature or disease. Every parasite sheltered by the ani-
mal means the loss of some pounds of meat, and every animal protected from parasites means always a corresponding gain. I have dwelt on this side of the question at some length because it is the one which is not generally regarded as sufficiently important to demand careful consideration. I am convinced on the contrary that it is well worth considering, even if there were no further possibilities in the case. The gain in flesh and in general health is more than sufficient to warrant some slight expenditure to attain this end.

The other damage wrought by parasites is apparent and extensive enough to need but little explanation. Every animal may harbor in addition to the free-living, active parasites, a long list of passive resting stages, the immature or larval forms of parasites, enclosed in cysts in almost any part of the body. In general it may be said that these have reached their position by wandering to it, usually from the intestine into which the eggs or embryos of the parasite were introduced in one way or another. The disturbances caused by the wandering of the larvae to their final resting place are sufficient to produce disease only when the number of larvae is large. The disease produced by *trichinae* is a good instance of this. If the number is small the only result is a lowering of the general health of the host and a general lessening of vitality and weight. Once at the end of their journey the larvae remain quietly until the host is killed and the flesh is eaten by some other animal. An exception to this harmless resting stage must be noted in the case of the "gid-worm" in sheep. Here the larvae which have made their way into the spinal column or skull increase in size so much as to press upon the spinal cord or brain and to give rise to dangerous disturbances as a result of the pressure. In most cases, however, the slight increase in size due to the growth of the larvae is unaccompanied by any harmful symptoms. But when, however, at the slaughter house the meat is examined, such organs as the liver, which are apt to contain these larval parasites, are rejected as unfit for use. Or else, as in the case of *trichina*, not only the organ but the entire animal may be condemned. The loss due to condemned meat is, no doubt, considerable, but actual statistics are hard to find. In 1891, at the New Orleans slaughter house, I find it recorded that 2,500 "flukey" beef and cow livers were destroyed; this represents a total loss of $1,900. At the same place 117 hog livers out of 2,000 were "measly;" in other words, *one in every seventeen* was rejected as unfit for food. The statistics with reference to condemned trichina pork I am unable to quote, but the amount lost is doubtless considerable, as any one connected with large packing establishments can affirm. Inspection of slaughtered meat is growing general, and is certain to become still more widespread as it should in the interests of the unprotected consumer.¹

Taken all in all, these many losses, small though each may be, constitute a steady drain on the profits of the stock raiser, a tax which he is paying; and yet the most serious side of the question has not been outlined.

¹ I have not dwelt upon the great dangers due to the sale and consumption of meat thus infected. They are so evident and so generally known as to need no explanation.
While there are always these constant yet minor losses, the greatest loss comes as a result of the occasional epidemics which, unforeseen and sudden, result in the destruction of a large part of a herd or flock. Their cause is easily understood; the constant limited number of parasites becomes augmented by an unusual combination of favorable circumstances for their development until the animals are utterly unable to stand the drain on their strength, and succumb to the attack. Such epidemics are well known in all stock-raising districts; it is rarely that they reach the height and extent of the famous “liver-rot” epidemics of England, which have carried off in a single year sheep to the value of $20,000,000. They are usually in our own country confined to a limited district and, because of the more isolated position of stock farms, to a single herd, ranch, or perhaps one valley. Such is the well known “tape-worm” disease of the western plains or the “fluke” epidemics more common in the moister regions near the Gulf. An epidemic of this character depends in part on natural conditions which are difficult to cope with, and in greater part on the sanitary condition of the stock, the range and the water supply which are directly within the control of the stock-raiser. And it is not too much to say that the loss can be entirely avoided by the exercise of proper, intelligent foresight and control of these conditions.

In the first place, however, the diagnosis of the disease must be exact. The method followed in many localities of proclaiming “worms” to be the cause is only one degree worse than diagnosing the parasites as “tape-worms” or “flukes.” Against such vague, general, all-inclusive terms too much can hardly be said. It would scarcely be regarded as sufficient today for a physician to call a disease a “fever,” yet the term does not include a greater variety of complaints demanding more varied methods of treatment than does the term “tape-worm” disease. Each separate and distinct species has a peculiarity of habit and effect on the host, and more particularly a characteristic life-history, which makes every species a separate source of infection. Unless the species and the life-history of each are accurately known all methods of cure and of prevention must needs be general rather than particular; they must be carried out with the hope that they may possibly be of service rather than the certainty that they will avail. Exact knowledge of two points is then necessary before the trouble can be met in the best way—first, the species which are parasitic in domestic animals must be so well known that they can be recognized without fail, and, secondly, the whole life-history of each must be so accurately delineated that it may be possible to arrest it at the vulnerable stage. Unfortunately both points are clear in only a few cases; in these they have shown their value in cases of epidemics, as will be clear if one turns to the description of the liver-fluke of sheep or the unarmed tape-worm of man given on a later page of this report.

To return again to the matter of diagnosis. Parasitic diseases have often little that is known to be characteristic in the way of external symptoms. Most of the prominent features are common to other diseases, and certain determination rests then on finding the parasite or some recog-
nizable part of it. Thus lung-worms may be identified from eggs, embryo, or even the worms themselves in matter coughed up by the animal infected; intestinal parasites are detected by similar remnants in the droppings, and blood parasites through the examination of a drop of that fluid. The positive identification of a species is no easy or rapid matter. Round worms are so small and tape-worms or flukes so similar in external form that considerable study of the internal structure is necessary to enable one to state with any degree of certainty what species lie before him. There are very few species which can be identified without the use of a microscope and a study of the internal structure. For this reason I have given in Appendix A a short summary of the simplest and best methods for the preservation and study of the various parasites. In the course of this paper descriptions of the various parasites are given in such detail that any one with patience to work out structure, often complicated, can determine the species; to aid those who may have had no instruction in zoology, or who are not in position to refer to text-books, the various organs are described in full and are illustrated by numerous cuts. It is hoped that in many cases at least, this may be sufficient; in any event this department stands ready to give all possible advice and assistance in the way of determining parasites and of suggesting remedies for their removal and prevention. It will be necessary, of course, to send specimens in order that a positive diagnosis may be made; instructions for preserving and sending are given in the same Appendix A. The diagnosis of a parasite is always more difficult from a fragment than from the entire specimen, and in many cases our knowledge of the forms is so imperfect that a decision cannot be reached. In the case of the tape-worms a well known species can be determined from a single joint or segment passed by the host if it be in good condition, i.e., not dried and shrivelled; and the peculiarities which make this possible are described in their proper place.

Most parasites have a more or less complicated life history. The young has to enter a different animal from that in which the adult lives, and in this it undergoes some changes before it is ready to migrate of its own will or passively, as the case may be, into the host in which it reaches its full growth, becomes mature, and produces its eggs. The importance of knowing these migrations and changes in full is evident, since on the life history depends the method of prevention to be followed in the special case. As the life history differs in closely related forms, no certain conclusions can be drawn for one species from what is already known with reference to a second species. A full knowledge of the changes through which a species passes furnishes at once a clue to the point at which the parasite will be the most susceptible to attack. Illustrations of this are found in the life history of the sheep liver-fluke, of the human tapeworms, of the Trichina and numerous other parasites. The life history is, however, of all branches of this subject the least studied, or rather known, for the difficulties are by no means insignificant. Every parasite spends the larger
part of its life in the dark beyond the ken of human eyes; here it lives, grows, reproduces, and dies. At times it comes for a longer or shorter stay into the open world, but it rarely remains there for more than a very brief period. In its world of darkness and mystery it is associated with many others much like itself, and, on the other hand, it sometimes undergoes extreme changes of form and structure so that positive recognition is difficult and wrong conclusions easy. In spite of all this the life history has been made out in many cases. There is need, however, of further work, especially on the native species which frequently give rise to much trouble, and the attention of scientific workers must be forcibly turned to these subjects as productive of scientific results as they are sure to be valuable to commercial interests in wide circles of our country.

The diseases caused by parasites have received in the past popular names, based usually on some more striking symptom of the trouble; "measles," "paper·skin," and "gid" are good instances of this. But the present tendency is to name each from the generic name of the parasite with the suffix *asis* or *osis*; thus the names *trichinosis*, *strongylosis*, *dismatosis*, and the more general term *helminthiasis*, are formed in this way. This reasonable method is sure to become gradually more widely used.

The treatment of parasitic diseases may be merely remedial so far as the infected animals alone are concerned. In this instance it consists in the removal of the parasites from the organ in which they are living, by medical means, as in the case of intestinal parasites, or rarely by surgical means, as has been tried on valuable stock afflicted with "grubs-in-the-head, or with the "gid," i.e., "worms-in-brain." At the same time some effort is made by the use of especially nourishing food and tonics, as well as by careful shelter from severe weather, to raise the general tone of the animal and to enable it to withstand more perfectly the drain of the disease on its system. Such treatment is both expensive and difficult to carry out, particularly in the large herds or flocks which make their home on our Western plains. It is, hence, to be avoided if possible, and this suggests the real, sound method of dealing with parasitical diseases, namely prevention, which will soon be discussed in full.

Before leaving the subject of remedial treatment of the particular animal infected, it may be said that the methods of such treatment are known in part at least to veterinary science. They vary largely with the nature of the disease, that is, the kind of parasite to be removed and its location. I am not a veterinarian and have no reason to be better informed on these methods than anyone who consults standard works on this subject. It is my intention to pass over this part of the topic with only occasional quotations from authorities, and dwell more strongly on the almost unemphasized possibility of preventive treatment. There is one class of parasitic maladies, due to the presence of considerable numbers of parasites in the intestine, which has so much of a similar character in various cases that the remedial treatment may be outlined in
general here. Some special features of the different cases will be noted later in the appropriate connection.

“Treatment * of intestinal helminthiasis consists in the employment of those medicaments named vermifuges, vermicides, and anthelmintics (especially taeniafuges). Their action may be assisted by a special regimen. ‘We advise giving to the Herbivora green food—in winter, carrots—frequently seasoned with salt; to horses, roasted oats; to dogs, as much flesh as possible, and a decoction of milk or of onions; to pigs, clotted, skimmed milk, green fruit, and acorns’ (Röll).

“When debility is pronounced, it is well to add a regimen of tonic substances, such as bitter plants and common salt.

“When there is colic or convulsions, we commence by giving appropriate medicaments to allay them—sweet oil, ether, opium, assafetida, and extract of hyoscyamus.

“The anthelminthic treatment should be preceded by half-diet for some days, and sometimes by slight purgation. A purgative may be added to the vermifuge, in order to expel the worms which are dead or stupified by the special drug; but it is preferable not to employ an evacuant until some hours after the administration of the anthelminthic. Recourse is generally had to drastics, especially to aloe, and sometimes also to calomel or castor-oil.

“A very large number of substances have been recommended for freeing the intestinal canal from its parasites; but many have a unwarranted reputation, and it is best to employ those, the efficacy of which is well established. Those most frequently used are arsenious acid, tartar emetic, santonine, the root of male shield-fern—especially in the form of ethereal extracts—tansy, benzine, empyreumatic oil, oil of turpentine, kousso, kamala, and bark of the root of the pomegranate.”

Far more valuable for the careful stock-raiser or for the farmer are the general principles of prevention which can be carried out by the exercise of a little care and “horse-sense,” and which will result not only in avoiding bankruptcy in an epidemic, but also in a general increase in weight and in the tone of the stock. In some cases this is the only method possible. Two instances will show this very clearly: positive indications of Trichinosis (Trichina disease) can be observed only after it is too late to remove the worms, and the farmer can do almost nothing; if the hog can stand it, it gets well; if it cannot, it dies! Again the tape-worm disease of lambs has not been successfully treated by medical means because the worms are in the gall ducts, beyond the reach of intestinal medicines.

The entire science of prevention is based upon the knowledge obtained by a study of the life-history of parasites. It is as firmly established as any scientific fact that all parasites reach their position in any animal from the outside world in some way or other. It may be that they pass directly as eggs, embryos, or young worms, into their abiding place, as in

*From Neumann, Parasites and Parasitic Diseases.
the case of most intestinal worms; it may be by long wandering through
the tissues, assisted, perhaps, by the blood current, as in the case of those
parasites whose resting place lies far from the gates of the body. One and
all, however, come from the outside through one of the natural openings
of the body. In the exterior, in the surroundings, among the substances
taken into the body, the source of infection must be sought, and once
found it must be rigorously guarded against. Here the life-history fur·
nishes the key to the situation, and so long as this history is unknown any
opinions must be based on probabilities, on inferences from other known
cases, and not on facts, concerning the species in question. It is clear,
then, why I have emphasized above the extreme importance of a better
knowledge of this branch of the subject and urged that more attention be
paid to establishing the facts in this field.

Since the source of infection is to be found in the food or drink, or in
the surroundings, evidently the same sanitary principles are operative in
the case of the domestic animals as for man himself; and just as the savage
shelters more parasites than the civilized man, and the idiot or maniac
than the normal man, because the latter has more regard to his surround­
ings and his food, so well kept stock are less troubled than that which is
neglected. If stalls or pens are allowed to remain littered by accumu­
lated manure and other refuse, the chance of parasitic invasion is greater
than if the quarters are kept free from such waste.

The item of food deserves still more careful watching. In the case of
stall fed animals there is little danger from any kind of vegetable food if
it is clean, that is, not soiled by the excrement of other animals. Her­
bivorous animals, when grazing, should be kept away from infected mead­
ows as a matter of course, and if the introduction of parasites in pur­
chased stock and by means of infected manure be guarded against there
is not much danger that the grazing places will become infected. There
is, however, always danger that human or dog tape worms may be brought
onto the range, and the stock raiser should keep a sharp watch on all dogs
and should enforce regulations with reference to the disposal of human
faeces, at least on the part of his own employees. Further explanation of
this matter and of the relations of the stock raiser to the prevalence of
human tape worms will be found under the discussion of these parasites.

Omnivorous domestic animals, like the hog and dog, require much more
careful watching with reference to food. They should not be fed the waste
portions of slaughtered animals unless these parts be first thoroughly
cooked. The very common habit of feeding everything of this character
to hogs cannot be too strongly condemned; for those parasites which do
not find a lodging place in the body of the animal will probably, in a very
large per cent of the cases, pass the alimentary canal entirely unharmed,
This is especially true of the eggs which are protected by an impervious
shell and which, when evacuated, find in the dung of the hog pen and the
moisture a favorable place for development, and afterwards, in the scat­
tering of the manure, an excellent chance of finding a suitable host.
The dog, sheep, and cattle have so many parasites in common, in the different stages of the life history, that it is simply increasing the probability of parasitic infection to permit a dog to eat of the uncooked remnants from slaughtered animals. Even in the case of verminous lungs, when the lung worms are foreign to the dog as a parasite, it can hardly be doubted that a large share of the eggs, at least, will pass unharmed the intestines of the dog and be widely distributed with his droppings, thus increasing the area of the infected fields and the chance of future epidemics. After a thorough boiling such remnants are entirely harmless.

The third and most important element in a protective campaign is the water. The most casual reading of the life history of the various parasites, as shown for instance in the later pages of this report, will not fail to show the important part played by water. There are very few parasites which, at some time in their life, do not pass a shorter or longer period of time and undergo some part of their development in water. Furthermore, it is by means of drinking water that a large number of parasites are introduced into the system of the host. This element deserves, then, the most careful control, and yet I think it is on the whole the one factor which is most often neglected. I have seen a yard used nightly for a considerable herd of cattle, when the only water was a half stagnant brook or series of pools through the center of the yard. It was soiled by the dung of the animals, and yet the owner would have been "surprised" had any one told him a "tape-worm" epidemic was his own fault. As a matter of fact the conditions could hardly have been more favorable; the eggs voided with the dung came in masses into the water where were myriads of small water animals and insects in which the larval stage of the tape worm could have been developed, and these swallowed by the cattle would grow to maturity in the intestine. Of course such extreme conditions are rare, and yet the other extreme is equally rare. If cattle are supplied with water from a deep well which lies far enough from the yard to make sure that no infection is possible, or if this be impracticable from a running stream preserved so far as possible from every kind of contamination, the chance of parasitic epidemic is very much less. Above all, the drinking places in yards must be elevated and kept clean and free from all sorts of refuse.

With range-fed cattle the matter is somewhat more different, since it is more difficult to regulate drinking places, or even to choose at all in some localities. Running streams are of course less likely to be infected than standing pools, especially if cattle have been in or around the latter. The dogs and herders are usually much more dangerous in the case of such cattle than the water supply, though I should not neglect to say that the tape-worm disease of lambs so common on the plains is yet entirely unexplained, and on the character of the intermediate or larval host of this tapeworm will depend very largely the sanitary principles to be followed.

*I should state that the host of the cattle tapeworm larvae is unknown, and of the past or future of the yard described I have no information. It is mentioned merely as an illustration of favorable conditions.
If the stock raiser, wherever he be, will only become acquainted with the principles concerned and the methods to be followed in guarding the field from infection, if he will be vigilant in quarantining all animals which are infected or suspected, in making away with the dung of such, and thus destroying the eggs or embryos, in removing unaffected animals to fresh pastures, and, if any trouble arises, in ascertaining at the earliest possible moment just what enemies he has to fight, and then becoming acquainted with the life history of these special forms, if he will see why he has to take certain precautions and adopt these rigidly at once, he will find the return far more than the expense.

No region of the world is better located than these broad western plains to furnish a supply of pure meat for the consumption of the world. So broad that animals are not herded in limited quarters but are free to roam, uncontaminated by the refuse of man or beast, with an open winter well calculated to destroy parasitic forms that might be introduced, and a rainfall so distributed that periods of dry weather, little favorable to parasitic development and spread, intervene between the periods of wet weather, these grazing regions present the most ideal conditions for entire freedom from parasitic diseases. If this desired state has not always been found, it is, to a large extent at least, due to lack of appreciation of the importance of the problem and lack of knowledge of the matters involved. I hope that these pages, given in this way a wide circulation through the limits of our own state, may result in some good to those most closely concerned in the practical questions involved. I shall always hold myself ready by answering questions, or advising so far as I can, to assist stock raisers, large or small, in meeting problems in this field. It will be a favor to all concerned if specimens of parasites, properly preserved, can be sent this department for identification and study; directions for preserving and sending are given in Appendix A. In this way information may be gained as to the number of parasites found in the state and the trouble caused by the same, and a valuable collection of these forms for both record and for subsequent reference may be made here in the State Museum. Address all communications and packages to H. B. Ward, Zoological Department, University of Nebraska, Lincoln.

PART II.—SPECIAL.

With one or two exceptions the internal parasitic animals belong to the branch known to zoologists as “worms.” They form there a natural group which falls easily into two classes, each of which has two orders. The relations of these orders to each other is shown in the accompanying table which will also serve as a key if it is desired to ascertain in which group any parasite is included.
The Trematodes or "Flukes" are parasitic flat worms, generally shaped much like a leaf; they are provided with at least one sucker which is usually at the anterior end and have an alimentary canal without an anal opening. In general appearance they resemble detached segments of a tape-worm which are often mistaken for them, but from which they are, however, easily distinguished by the possession of an alimentary canal and one or more suckers.

The family of the Distomidae includes almost all the common parasites of this group, which are found in man or in the domestic animals. These are the forms to which the name "fluke" is ordinarily applied, and representatives of this family may be obtained from a wide range of hosts. The adult forms are parasitic in the intestine, liver, or lungs, and the larval forms are found in a resting stage, encysted in various organs. They require at least one larval host, which is a mollusk (bivalve or snail) in which part of the development is passed. The appended table shows the occurrence of half a dozen of the more important species of the family:

<table>
<thead>
<tr>
<th>Host</th>
<th>Fasciola hepatica</th>
<th>F. magna</th>
<th>Distoma lanceolatum</th>
<th>D. sinense</th>
<th>D. conjunctum</th>
<th>D. felinum</th>
<th>D. Westernnii</th>
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<tr>
<td>Man</td>
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</tbody>
</table>

†The form from the cat and dog identified as D. lanceolatum is really D. felinum.
The body of the flukes consists entirely of soft tissue without hard parts or a skeleton of any sort. The large amount of muscle present gives an extreme degree of flexibility, and consequently the form varies greatly at different times so that for the positive determination of the species, that is, the identification of the parasite, a general knowledge of its structure is indispensable. For the sake of those who may desire to preserve specimens and examine them at a later date or to keep them for reference, some simple methods of preparing specimens are given in Appendix A. The examination of the living worm is, however, easier, and in many ways more satisfactory, and is the only method which can be followed under many circumstances. If the worms are placed alive as they come from the host in a very weak solution of common table salt in water* they will remain alive for twenty-four hours or more and can be examined at leisure. Before being examined the worms should be washed free of slime or other foreign matter that they may be as transparent as possible. If the worm then be laid flat on a small plate of glass carefully cleaned on both sides and covered first with a few drops of the salt solution and then with a second plate of clean glass, it is ready for study. Where they can be had, glass slides and covers used for microscopic study are more convenient and satisfactory than odd pieces of glass. The salt solution about the worm should be renewed from time to time as it evaporates, yet not so frequently or abundantly that it serves to support the weight of the upper or cover glass. The slight pressure of the latter is necessary to prevent too great movement of the worm and to make it somewhat more transparent. In a very short time, which varies with the different species from a few minutes to an hour, the worm is sufficiently transparent that the internal organs can be seen and their relative position determined.

For the purpose of explaining the general structure I have selected a species of fluke parasitic in the liver of the house cat (Fig. 1). It is not only comparatively common in Lincoln, occurring in about one cat out of every four or five examined, and hence can be easily obtained for comparison with this description, but it is also very transparent and not complicated in structure, so that it is an exceptionally good species to take as an introduction to the study of these worms. Its presence cannot be detected in ordinary cases by any external peculiarities of the liver, but on following the bile ducts from the lower surface towards the center of the organ,

*Approximately a round teaspoonful dissolved in a quart of water; more exactly six to seven parts of salt in a thousand of water.
one finds from time to time leaf-shaped bodies rolled up lengthwise, and lying in the ducts with the more pointed end toward the smaller part of the canal. They are covered by mucous mixed with the brownish yellow bile so as to be perfectly opaque; on washing them, however, in the salt solution and placing between two pieces of glass, as already described, they present when viewed under a good lens, or, preferably, a microscope, the appearance shown in Fig. 1. The body is shaped like a long, narrow leaf; the larger end is more rounded, and is the posterior end of the worm. The narrow conical "head" or anterior end, seems to be almost without any internal organs except at the very tip. This narrow portion is frequently called the "neck;" it is not at all separated from the "head" and only very indistinctly from the body proper by a slight increase in breadth and by the appearance of dark, prominent internal organs.

On the lower side of the head (Fig. 2) near the tip is a small round opening, the mouth; it is surrounded by a cup shaped mass of muscles making what is known as the oral sucker. The diameter of this organ is regarded as one point in fixing the species, but it varies not a little in different specimens and at different times, owing to the degree of contraction at the time when it is measured. Partly above and partly behind the oral sucker one sees in the body an elliptical organ of much the same general appearance as the sucker. This is the pharynx, so-called, a muscular bulb which surrounds the entrance into the oesophagus, the first part of the alimentary canal, and by means of which this opening may be entirely closed. Extending backward from the pharynx is a short, straight, thin-walled tube, the oesophagus which divides into two branches, the intestinal branches; one of these passes backward on each side of the body and may be followed easily up to a short distance from the posterior end where it terminates blindly (Fig. 1); there is no anal opening. The branches of the intestines are not uncommonly filled with a substance resembling in color the bile; it is, in fact, that which has been taken in as food.

The excretory system is represented (Fig. 1) by the long tubular reservoir which opens at the external posterior end of the body by a fine excretory pore, and extends forward in an "S" shaped curve about one-third the length of the worm; here it breaks up into branches, the further course of which is not represented. In worms which have lain some time in salt solution the branches of this system are distended with a clear amber fluid, and can be easily followed through all parts of the body.

The nervous system is not represented in the cut; it consists of a mass of nerve cells on either side of the pharynx connected by a band of fibres. This is the primitive brain from which the nerves extend to all parts of the body. Organs of sight and hearing are not found, and even special organs of touch are yet to be demonstrated. On the whole it may be said that the nervous system is in a very degraded condition, as is characteristic of parasites in
general, and internal parasites in particular. Food and shelter being provided by the host, such organs as are used in the quest for nourishment and for protection are evidently superfluous, and are not developed.

On the lower surface of the body, about where the neck ends, is a spherical structure partly covered by the dark mass of the internal organs. It is in structure exactly like the oral sucker, and is the second of these organs characteristic of this family, the ventral sucker or acetabulum. It is a muscular cup like the oral sucker, but, unlike that, has no opening into the interior of the body; it is simply an organ for attachment, and with the oral sucker enables the worm to move by the alternate fixing of the sucker and the contraction of the body in more or less the way in which an "inch-worm," or "measuring worm" walks.

All of the other organs shown in the figure belong to the reproductive system. It requires no further proof than a glance at the cut to show that this system is the most complicated and highly developed of all. This genus is hermaphroditic, that is, each worm contains all the organs of both sexes. The male organs are simpler and may well be considered first. In the posterior third of body within the curves of the excretory reservoir lie two irregular solid organs. These are the testes in which the male fluid is produced. A fine tube extends forward from each and is lost under the dark mass in the center of the body. These two tubes join and reappear on the right of the figure near the ventral sucker. Here the tube is somewhat enlarged and serves as a receptacle in which the sperm is stored up. This reservoir curves around the ventral sucker and opens at the genital pore, a small opening at the center of the body immediately in front of the ventral sucker. There is no male copulatory organ in this species.

The female organs exhibit a peculiarity not common among animals. There are two glands, one of which, the ovary, produces the egg-cells proper, and the other of which, the yolk glands or vitellaria, produces the yolk for the nourishment of the egg cell during its development. The ovary, a slightly elliptical, solid organ, is located in the center of the body, about as far in front of the foremost testis as that is ahead of the other testis. Towards the ovary converge from the sides the four ducts of the paired yolk glands. These are not solid, but grape-shaped (racemose) glands, and are the only organs situated between the branches of the intestine and the outside edge of the body. Their extent and parts vary somewhat in the specimens from Europe and in those found in Lincoln, so that it seems advisable to give some details with reference to both cases. Those who have studied the European form describe the vitellaria as situated in the middle third of the body, and composed of eight to nine groups of acini with transverse ducts from the next to the last. The figures bear out the statements, and show the posterior end of the vitellaria as approximately coincident with the position of the ovary and the transverse ducts as extending backward from the glands toward the ovary at an angle of about 45° with the main axis of the body. In the specimens found here the conditions, as represented in the figure, are as follows: The glands begin about half as far behind the acetabulum as that is from the oral sucker, that is, at approximately the same position as in the European form, but they extend to
the middle of the space between the two testes, or even sometimes as far as the anterior edge of the posterior testis. One break in the line of acini may always be recognized as most prominent; it is located just opposite the ovary on each side, and is in length more or less equal to the diameter of the ovary. This is the condition shown on the left side of the worm figured. This space divides the vitellarium into two portions, which may be distinguished as antovarial and postovarial. While it is in some cases possible to distinguish in the antovarial portion groups of acini, they seem to be usually rather indistinct, or at least very unequal in size, as if adjacent groups had become confluent by the growth of interlying acini. The postovarial portion, however, is usually distinctly divided into two or three groups of acini, though even these may be obliterated. In two or three cases a small group of acini was found, on one side only, in this intermediate space opposite the ovary, and was clearly separated from both antovarial and postovarial portions by a small space. This was the case in the right vitelline gland of the worm figured.

Corresponding to the two portions of the gland, one finds on each side two ducts which, extending obliquely toward the ovary from a short distance before and behind it, form a "Y" or "V," according as they meet before or not until after reaching the ovary. These ducts on either side of the ovary form one of the most characteristic appearances of the specimen. By means of these ducts the yolk material is carried to a small yolk reservoir (Fig 3) on the upper side of the ovary; a short tube from this joins the oviduct soon after it leaves the ovary. The delicate radiating cells at the anterior edge of the ovary in the figure form the so-called shell gland (S.G., Fig. 3) which surrounds the beginning of the uterus (U). Here the egg cell is surrounded by a mass of yolk matter from the yolk reservoir, and the whole enveloped by a thin shell which is at first almost colorless, but grows rapidly yellow, then brown, and finally almost black. These changes in the appearance of the shell take place while the egg is passing forward through the uterus. This organ lies in close coils, filling almost the entire space between the branches of the intestine at the sides from the ovary behind to the ventral sucker in front. The dark color is due to the closely crowded masses of eggs, which are pushed very slowly forward and are finally gradually discharged from the common genital pore already mentioned. During its passage through the length of the uterus some changes take place within the egg shell, so that whenever free the shell contains an embryo either partly or wholly developed. The egg shell of a fluke shows a characteristic lid at one end which, under certain circumstances, opens and sets the contained embryo free. This will be further described in connection with the life history.

![Figure 3](image_url)
Two small organs are yet unmentioned. At the left of the ovary a short, horn-shaped tube extends backward and ends at a small pore on the upper surface without connecting with any other parts. This is the so-called Laurer's canal (LC, Fig. 3,) and may be regarded as a rudimentary organ. It is not usually as prominent as in this species. Occupying a similar position on the right is an elliptical body known as the sperm receptacle (SR). The connection of these parts with the yolk ducts and oviduct is shown in Fig. 3.

This description of the internal structure of the fluke shows very clearly one characteristic feature of all parasites, namely, the excessive development of the sexual organs. As a result of this the worm produces an enormous number of eggs and could all find the necessary condition for development it would result in the increase in the number of parasites to such an extent that the hosts would be destroyed. The life-history of the flukes is, however, so complicated that a large number of eggs or embryos are destroyed at every stage in it, and only the few are ultimately able to reach their proper host. Since the life-history of this cat liver fluke is entirely unknown, it is better to leave the discussion of this matter until later; it will be fully considered under the sheep-liver fluke.

A diagnosis of the species just described is as follows:

**Distoma felineum** Riv. 1884.

*Syn.—D. conus* Gurit 1831, nec Creplin 1825; *D. lanceolatum* v. Sieb. 1836; *D. truncatum*, Rud. (in part).

Body elongated, transparent, flat; length 10 to 21 mm.; breadth 1 to 2.5 mm. Anterior end conical, posterior rounded. Oral sucker 0.28 to 0.41 mm.; ventral sucker 0.24 to 0.28 mm. in diameter, about one-fourth of the length from the oral; pharynx next to oral sucker and 0.16 to 0.22 mm. in length, oesophagus short; branches of intestine extend nearly to posterior end of body. Two lobed testes in posterior third of body, one anterior to the other; ovary elliptical, a little in front of testes; uterine in coils from ovary to ventral sucker; vitellaria lateral, occupying middle third of body and extending posteriorly to second testis. Genital pore immediately in front of acetabulum. Eggs 25 to 30 μ long, 12 to 15 μ wide.

*Occurrence.—Distoma felineum* has been obtained in Europe from the liver of the cat, dog, and glutton, and more recently in Siberia from the human liver, where it seems to be not uncommon, having been found in 8 out of 124 post mortems. It was found in Lincoln not only in the cat, but also in the gall ducts of a young coyote, *Canis latrans* Say, which had been kept here three months as a pet, and had met an untimely fate in consequence of over feeding. In one instance one hundred were found in a cat liver, and in the other cases about a dozen each.

*Pathology.—In every case the liver of the infected animal was carefully examined; the worms all lay in the dilated ducts, and even in the case of extreme infection there could be observed neither destruction of the tissue nor other pathological changes in it. In color the living distome is a clear amber, with the vitelline glands, testes, ovaries, and the posterior portion of the uterus of
a chalky white. The last named organ changes gradually toward the anterior end until it becomes a dark chestnut brown.

An extended account of the flukes in this group of the genus *Distoma* has been published by Stiles and Hassall.* These authors give figures and description of a dozen forms, including several parasites of man, cat, and dog which must be passed here without further mention. Among these is *D. lanceolatum*, the small sheep liver fluke of Europe which has never been found in this country.

The **Human Lung Fluke** is perhaps the most dangerous human parasite of this group at present known in the United States. A native of China and the East, I have recently discovered two cases of its occurrence in this country, and it is no doubt among us. It may be recognized from the following description and figures which are reprinted from the *Medical News*.

**Distoma Westermannii** Kerbert 1878.


Length, 8 to 20 mm. Breadth, 4 to 8 mm. The body is thick and plump, somewhat resembling a dipterous larva in shape (Figs. 4 and 5), with the posterior end more pointed than the anterior, and the ventral surface much flatter than the high arched dorsal. In color the living distome is deep red or reddish-brown, darker along the middle of the body. The cuticula is everywhere covered by broad, flat spines of varying length and size, which are lacking in poorly preserved specimens.

The suckers are notably small and often difficult to see. The oral sucker has a mean diameter of from 0.6 to 1.2 mm. It is not situated at the exact anterior extremity of the body, but is slightly subterminal, and its orifice is directed downward. The ventral sucker, or actabulum, is about the size of the oral, being 0.65 to 1.31 mm. in diameter. *Esophagus* very short, branches of intestine sinuous. Testes two, much lobed, located one each side of middle behind ventral sucker. Ovary low, situated at the right of the ventral sucker, coils of uterus massed in the same position on the left side. Eggs with thin, yellow shells, 0.08 to 0.118 mm. long by 0.048 to 0.055 mm. wide.

The fluke has been found in the lungs of tiger, cat, and dog as well as man. With regard to the region in which this parasite exists it may be said that

*Veterinary Magazine, June, 1894, p. 413.*
Japan, China, Corea, and Formosa are known to be seriously infected. In one district of Japan, according to Bälz, almost every inhabitant suffered. In Formosa 15 per cent of the entire population was infected. No doubt the disease is at home in the entire eastern portion of Asia, and has been introduced into America by immigrants from some country of the East.

Life History.—The oval ciliated embryo develops within the egg (Fig. 6,) some time after it escapes from its host. "The fate of these embryos," says Leuckart "is at present entirely unknown. That they wander directly into the latter host contradicts all analogy. They will probably, as is known of other forms next seek an intermediate host, and in this produce a generation of cercariae, which then, for the first, are brought in one manner or another into a man, whether directly into the lung, as Bälz assumes, is at least questionable. Much more probable is it that the residence in that organ is the result of a further migration."

Pathology.—The parasites give rise to the tumors in the lungs; these tumors occur mostly about the roots and along the dorsal borders of both sides. On opening the tumors distomes were found within; some were surrounded by a capsule, while others were burrowing after the fashion of the large distomes in the livers of sheep and cattle. These burrows were filled with débris and pus. In the cysts are found not only the distomes but also eggs and masses of Charcot's crystals, and the mucous from the lung contains both eggs and crystals. The number of eggs discharged in the course of a single twenty-four hours by a patient who had suffered thirteen years from the disease was estimated to be not less than twelve thousand!

Symptomatology.—When in the lungs, its common abiding place, the distome gives rise to periodic hemoptysis and chronic cough, with rusty mucoid expectoration. The general appearance of the expectorations is identical with that in tuberculosis, and, as a matter of fact, in Japan, the disease was formerly diagnosticated as tuberculosis. The presence in the sputa of the eggs already described and figured is the only characteristic symptom, and positive diagnosis will rest then on the microscopic examination of the sputa, which will reveal, in case the parasite be present, numbers of its yellow-brown egg-shells.

The accidental rupture of a large blood vessel by the destruction of the lung tissue, and, in the severest cases, general anemia seems to be the only dangers to be feared. On removal from an infected district patients have apparently entirely recovered. During the continuance of the disease almost every patient suffers from malaise.

Treatment.—This parasite is not likely to affect other domestic animals than dogs or cats; and unless the animal infected is very valuable it had better be killed at once. If it is not killed there is only one method which can be suggested here, and which, on account of the grave danger of human infection if care is not taken, must be followed exactly; it is the close quarantine of the animal affected. Removal from suspected quarters, and, above all, a supply of
fresh, pure water, will probably result in the gradual dying out of the disease. Dog-houses or troughs which could be infected by the diseased animal should be washed frequently with a disinfectant solution to kill eggs that have been coughed up.

Very closely related to the genus *Distoma* is the genus *Fasciola*, which many writers, indeed, yet include under the first name. The forms in the genus *Fasciola* are, however, not only very much the larger, but always have a branched alimentary canal, and in addition show in other organs as well the same tendency towards branching. Thus both ovary and testes are much branched and the yolk glands much more than ordinarily developed. Two species of this genus, one introduced and one probably native, are found in this country. Here, as elsewhere, they are the most dangerous of all flukes and do a large amount of damage.

Among all the flukes no one is more widely known and feared than the famous sheep liver fluke, which is the cause of the “liver rot” in England and on the continent. A diagnosis and full account of its life history are given here:

**Fasciola Hepatica** L. 1746.

*Syn.—Planaria latuiscula* Goeze, 1782; *Distoma hepaticum* Abildg. 1786; *F. humana* Gmelin 1789; *F. lanceolata* Rud. 1803; *Fasciolaria hepatica* Anon. 1845; *Distomata hominis* Taylor 1884; *Distoma caviæ* Sous. 1890.

Body broad, leaf-shaped, with conical anterior end. Average length 25-30 mm., breadth 8-13 mm. Conical tip about 3-4 mm. long. Cuticula covered by numerous scale-like spines. Oral sucker at anterior end of body, small. Ventral sucker at junction of tip with main body, very little larger. Midway between the suckers the genital pore from which the curved cirrus often projects. Uterus short, thick, closely coiled, immediately behind the ventral sucker. Ovary and testes both much branched, as is also the intestine. Eggs oval, 0.13 to 0.14 mm. long, 0.07 to 0.09 mm. wide.

*Fasciola hepatica*, or the sheep liver fluke, as it is ordinarily termed, is spread over almost the entire earth. In Europe, Australia, South and North America, it is found and here, at least in certain regions (Arkansas and Texas), is exceedingly common. It has evidently been introduced with sheep, in the gall ducts of which it is most commonly found. It has been obtained, however, from the liver of the cow, horse, mule, stag, goat, pig, rabbit, hare, squirrel, elephant, and even man himself. It is not so common in the United States as has been believed, and many accounts of its presence depend upon the confusion with it of the great fluke (*F. Magna*), the next species to be described. Yet some instances of its occurrence are certain. I have myself received undoubted specimens of this species from Texas through the kindness of Dr. Francis, of the Texas Agricultural College.

**Life History.**—The eggs (Pl. 1, Fig. 2) of the fluke are deposited with the droppings in immense numbers. In spite of some statements to the contrary, there seems to be little doubt that they are to be found here at all seasons, though more plentifully in the moister parts of the year, a fact well in accord
with its life history. Of course the abundance of eggs will be further dependent upon the degree of infection.

If such an egg be examined it will be found to be covered by a firm brown shell (Pl. 1, Fig. 2a) provided with a small lid at one end; this may be sprung open by applying a little pressure to the whole. In an egg taken from the uterus of the fluke will be found a single egg cell surrounded by a quantity of yolk matter. During its stay in the uterus of the fluke the egg cell has divided and eggs taken from the droppings of the sheep contain a mass of cells, the developing embryo, which is surrounded still by a mass of yolk material. Not all of the eggs find conditions fitted for further development; they are entirely unable to stand drying and so in many cases perish at once. Only if they fall into water or onto moist earth where protected from the sun can the development proceed.

The rapidity of the development depends directly upon the temperature, and in summer from four to six weeks are necessary for the growth of the embryo. This, when hatched, has an elongated body (Pl. Fig. 3) covered with very fine vibratile hairs; at the forward end is a conical perforating apparatus (a), and on the upper surface a black, X-shaped spot (b) which is called an "eye spot." The anterior portion of the body is filled with a granular mass which is the rudimentary intestine, and in the posterior half of the embryo one finds a group of large cells, the germ cells, which are already well advanced.

By means of the vibratile hairs or cilia the embryo makes its way rapidly through the water in search of its proper host; if none be found, its death is said to occur within about eight hours. If, however, in the course of its wanderings it meets a small snail, it is in position to enter upon the next stage in its life history. In the choice of a host, the embryo is particular; the only species in which it has been found to develop freely in Europe is the common Lymnaea minuta s. truncatula (Pl., Fig.6), a very small snail, measuring about three-eighths of an inch in length, and widely distributed. Investigations are lacking to show whether the same species or some other serves as the host for the embryo in other regions in which the fluke is found. But if this species is present in any region in which the liver fluke is epidemic, it would doubtless be found to be the host of the embryo. L. humilis Say is suspected of being the North American host.

If, in its wanderings in the water, the embryo of a fluke finds one of these small snails, it bores its way into the soft tissues of the snail by means of its conical perforating apparatus, and comes to rest somewhere near the pulmonary chamber of the snail. The first change is the loss of the layer of hair cells which, like an old garment, is cast aside, the body becomes compressed (Pl., Fig. 4), often almost spherical. It is now a sporocyst or spore sac, and enters upon a period of rest and reproduction. The large germ cells, already mentioned as found in the body of the embryo, begin to grow and separate into small spheres. These elongate and gradually develop each into a "nurse" or redia (Pl., Fig. 7). The growing young ultimately burst the parent sac in which they are, and once free each redia makes its way through the tissues of the snail into some organ, preferably the liver, which lives at the apex of the snail shell.
PLATE I.

FASCIOLA HEPATICA.

This plate, which was kindly loaned by Dr. Francis, of the Texas Experiment Station, is reproduced from Curtice’s "Animal Parasites of Sheep," published by the U. S. Bureau of Animal Industry.

Fig. 1. Adult fluke, natural size; la, young fluke, natural size (Railliet).

Fig. 2. Eggs; a, with developing embryo; b, with embryo; c, egg shell (Railliet).

Fig. 3. Ciliated and free embryo; a, perforating apparatus; b, eye spot (Leuckart).

Fig. 4. Encysted embryo found in snails (Thomas).

Fig. 5. Diagrammatic representation of digestive and nervous system; a, oral sucker; b, pharynx; c, oesophagus; d, main branches of intestine; e, smaller branches; f, nerve ganglia; g, ventral nerve (Railliet).

Fig. 6. Limnaea truncatula, the snail which is the principal larval host of the fluke in Europe; a, the same, natural size (Railliet).

Fig. 7. Redia of the fluke; a, mouth; b, pharynx; c, intestine; d, masses of germ cells (Leuckart).

Fig. 8. Older redia containing cercariae; a, b, c, as before; d, cercariae (Leuckart).

Fig. 9. Cercaria dissected from its cyst; a, oral sucker; b, ventral sucker; c, pharynx; d, branch of intestine (Leuckart).

Fig. 10. Grass stalk with three encysted cercariae, a, a, a, (Thomas).

Fig. 11. Free swimming cercaria (Thomas).

Fig. 12. Cercaria slightly older than Fig. 11 (Thomas).

Fig. 13. Sexual apparatus of the liver fluke; a, beginning of the digestive canal; b, ventral sucker; c, e, the testes; d, f, ducts of the same; g, seminal vesicle; h, genital sinus; i, cirrus pouch; j, ovary; k, oviduct; l, shell gland; m, yolk glands; n, longitudinal, and o, transverse yolk ducts; p, uterus; q, metraterm [i.e. end of uterus] (Railliet).
Such a redia (Pl., Fig. 7), is a long slender form with mouth, bulb-like pharynx, and rod-shaped intestine. Two short conical stumps beyond the middle of the body look like rudimentary legs. A small birth-opening is present on one side near the anterior end; and the interior of the body shows even at a very early stage the same large germ cells which were found in the sporocyst. The fate of these germ cells depend directly on the time of year, i.e., the temperature. While in winter the development proceeds slowly, and the germ cells of the redia give rise to forms like the parent, the case is very different in spring or summer under the influence of the higher temperature. Then the germ cells develop to tailed larvae or cercariae (Pl., Fig. 8d). These mature successively, and, escaping from the redia by means of the small birth-opening already mentioned, make their way out of the snail into water in which they swim rapidly about by means of the long tail they possess (Pl., Figs. 11, 12). Not only the tail, but the body proper, also, shows great activity, so that it is difficult to get a good view of the internal anatomy—but even in motion the important structures may be faintly distinguished. The mouth in the oral sucker, the short oesophagus, and two branches of the intestine almost covered by the same large opaque glands at the side of the body, and between these the ventral sucker at about the middle of the space from the mouth to the point of attachment of the tail, remind one strongly of the typical fluke already described. And in truth the cercaria is the young fluke, so young that sexual organs are not undeveloped, and possessing in the tail a powerful swimming organ which the full grown fluke lacks.

Once free from its host, however, the cercaria does not continue long to swim about in the water, but coming in contact with some solid object, such as a piece of wood or stone, a plant stem or a blade of grass, it settles down, throws off the tail, and, as it draws its body up into a ball, presses out from the glands on the sides an opaque granular secretion which soon hardens about the animal into a solid opaque covering (Pl., Fig. 10a). In this condition the animal may remain unaltered for a considerable period. But before tracing its further history one point should be noted. The wider distribution of these cysts is provided for by the snail; it wanders over the meadows, and from it escapes in all parts of the field these cercariae which find a resting place as soon as free upon a blade of grass and await the next change. These cysts occupy, usually, according to Thomas, the lower leaves of the plant, and hence are more liable to be eaten by sheep than by cattle. A single embryo produces in developing at least 400 cercariae, according to the calculations of Leuckart, and as the number of eggs produced by a flock only slightly infected would be in the thousands, it is easy to see the extent of the infection.

The later history of the worm is easily seen. These cysts are taken into the stomach of the host in feeding, and then the covering is dissolved and the young fluke set free (Pl., Fig. 9); it seeks first the intestine, and then, by way of the gall duct, the liver. Here they ascend the bile ducts and are found with the head pointed towards the finest branching of these ducts. Having penetrated as far as possible they appear to rest, increasing steadily in size. A month or more is necessary for them to attain maturity, which is brought about by the gradual development of the sexual organs and a change in general form. The half of
the body behind the ventral sucker grows proportionally very rapidly, in both length and breadth, while the anterior portion remains more nearly unchanged. There results from this the peculiar form of the adult with the conical "head" portion and the large body (Pl., Fig. 1, 1a).

**Structure.**—The cuticula or external layer of the body is covered by short spines thickly set. They point backwards and aid the fluke in maintaining its position in the bile duct. The digestive system (Pl., Fig. 5) begins at the mouth (a) in the oral sucker behind which follows a spindle-shaped muscular pharynx (b) and a very short esophagus (c). From the end of this two intestinal branches (d) pass one to the right and one to the left; these branches are not simply like those in the young worm (Cercaria Pl., Fig. 9), but are very much branched. The flukes live on the brownish mucous which fills the biliary ducts, and when the tissue of the host has been damaged by the fluke, blood and liver cells are found in the intestine of the worm.

The testes are branched tubular organs (Pl., Fig. 13 c, e) which fill the entire central part of the middle third of the body. The fine ducts extend forward to a reservoir just behind the cirrus (i) or conical copulatory organ, which is a prominent feature immediately in front of the ventral sucker. This cirrus may be inverted and then is seen projecting from the genital opening, often being curled like a horn. The yolk glands (m) are much branched grape-like clusters extending along both sides of the body. One can easily see on either side a longitudinal duct (n) and just in front of the middle an opaque line joining them, the cross, or transverse duct (o). Immediately in front of this on one side lies the branched tubular ovary (i). The duct from the ovary extends towards a little enlargement in the yolk duct, the yolk reservoir, and in front of this lies the shell gland (l), a dark spherical body. Here the egg cell from the ovary receives its yolk, or nourishment, and its shell and passes into the first coil of the uterus (p). This latter organ shows its coils densely packed with eggs between this point and the ventral sucker; from the front of the coil a nearly straight tube (q) passes forward to the genital opening. This tube is ordinarily empty, but it is the path by which eggs reach the outside. The major part of the body consists thus of the sexual organs, and the immense number of eggs produced by each individual is not at all out of proportion to the development of these organs. It is this immense number which makes the danger of infection under favorable circumstances so great and demands extreme care to prevent the spread of the parasite even though conditions be somewhat unfavorable.

**Pathology.**—When the young flukes enter the liver they are very small and are able to penetrate far up towards the ends of the canals. Having proceeded as far as they are able, even by rolling the body and forcing the head into the duct, they become quiet, and are never able during life to retrace any part of the road, for the spines which cover so thickly the surface of the body all point backwards and serve to anchor the worm in place. The irritation gives rise to inflammation of the liver, to local hemmorrhage, and soon to general anemia. The symptoms are not easily detected at first; loss of activity, paleness of mucous surfaces, and a tendency to fatten, due to the better assimilation of the food resulting from the increased flow of bile. Weakness makes its
appearance and becomes more prominent. At this stage the eggs of the fluke may be detected on careful examination of the droppings. Loss of appetite and irregularity of feeding is accompanied by increased thirst and gradual wasting of the sheep. The extreme stage of the disease is soon reached; the animals become leaner, the temperature very variable, mucous surfaces very pale, all strength seems lost, and local oedema (puffiness) is very marked. If the animal survives this stage, the symptoms grow less marked, and yet a complete cure is exceptional. The changes which have taken place in the liver are so violent that they are never fully repaired.

The duration of the disease is extremely variable. It may be that acute inflammation of the liver carries off the sheep in a few days, or it may extend over a period of two to six months. Of course during the continuance of the disease or afterwards the animals are peculiarly liable to attacks of other sorts which find them but poorly fitted to resist. Autopsies show lesions in the liver and the presence of numbers of flukes in the organ. This number is ordinarily about 50 to 100; it may reach 600 to 800, and has been known to be 1,000. Each distome produces 500,000 eggs, according to the calculations of Thomas, so that the general degree of infection of the pasture can be readily imagined if not computed.

TREATMENT.—For the diseased animals themselves no successful remedy has yet been obtained. The parasites are rather beyond the reach of medicine. Here it is pre-eminently true that prevention is the only resource of the sheep-raiser. Infected sheep, especially if common stock should be slaughtered at once before the flesh deteriorates. There is no element of danger save in the livers, which should be burned. Before it is used the manure from infected flocks should be thoroughly mixed with lime and salt, which destroy the eggs and embryos of the fluke. For the same reason dressings of lime and salt should be used on the infected pasture. These will destroy the snail as well as the embryos or eggs. Moist pastures are to be avoided, and should be drained and diverted to other purposes for some time. Close grazing is more liable to infect the flock since the cercariae are encysted on the lower parts of the grass blades. The danger in pasturing sheep on infected ground is so great that they should not be permitted to return to an infected pasture until it has been thoroughly treated and until some time has elapsed. A daily allowance of salt is advisable even after they are returned to the old ground. It should not be forgotten that the disease is more prevalent in wet seasons or damp regions and that under such circumstances too great precautions cannot be taken in advance that neither flock nor pasture become infected. The loss from a single epidemic will wipe out years of profit. The parasites are probably always introduced by purchasing infected sheep, and a few parasites may, under favorable circumstances, in a short period of time, seriously infect a whole region. It is necessary, then, to exercise great care in the purchase and introduction of new stock and to procure evidence that new animals are not infected rather than to introduce them depending upon the chance that they probably are not.

The Grand Fluke is probably a native of this country though first reported from a zoological garden in Italy. It is often confused with the last
species (F. hepatica) which it closely resembles but is undoubtedly distinct, as
the following specific diagnosis will show:

_Fasciola Magna_ (Basi) Stiles, 1894.

Syn.—_Distoma magnum_ Bass. 1875; _D. hepaticum_ in part Curtice 1887; _Fas-
ciola hepatica_ in part Dinwiddie 1889; _F. carnosa_ Hassall 1891; _F. americana_
Hassall 1891; _D. texanum_ Francis 1891; _D. crassum_ in part Leidy 1891;
_Cladoceolium giganteum_ in part Stossich 1892.

Body flesh-colored when alive, broad, thick; much larger than _F. hepatica_;
length 23 to 100 mm.; breadth 11 to 26 mm.; thickness 5 to 4.5 mm. The
conical anterior part is hardly set off at all from the posterior. The posterior
end is bluntly rounded, and margin more convex. In general the structure is
very similar to _D. hepaticum_ except that the oesophagus is longer, the intest-
tines more branched, and the yolk glands confined to the ventral side of the
intestine; eggs oval, 0.109 to 0.168 mm. long by 0.075 to 0.096 mm. wide.

This fluke has been the subject of special study by Francis of the Texas
Agricultural College, and by Stiles of the Bureau of Animal Industry at Wash-
ington, D. C. It is found in cysts in the liver of cattle and of several species of
deer and is very widely distributed, occurring on the authority of various per-
sons in Texas, Arkansas, California, Iowa, Illinois, New York (Adirondacks),
and Italy. It is probably present in most parts of this country. In importance
it stands hardly second to _F. hepatica_, but of its life-history nothing is
definitely known, and for further details on the anatomy than are shown in Plate II.,
those interested should consult the papers quoted. It is of course probable that
it resembles _F. hepatica_ in its life-history as well as in structure. Methods of
prevention of the same character will probably succeed.

The genus _Gynaecephorus_ differs from all other distomes in having the sexes separate; the female
is cylindrical, and is held in a canal formed by the infolded edges of the body of the male. The two
branches of the intestines are united to form a single canal in the posterior quarter of the body.
The members of this genus are among the most feared of human parasites, living in the blood and
giving rise to dangerous symptoms.

The Human Blood Fluke. (Fig. 7). _Gy-
naecephorus haematobius_ (Bilharz) Dies. 1858.

Syn.—_Distoma haematobium_ Bilharz 1852;
_Bilharzia haematobia_ Cobbold, 1859; _Schistosoma_
haematobium_ Weil., 1858; _Thecosoma haemat-o-
muim_ Moq. Tand., 1860; _Distoma capense_,Harley,
1854.

Male 11 to 14 mm. long, 1 mm. wide. The flattened anterior end is very short, and bears the
two suckers. These have a diameter of 0.24 mm., and are very prominent. The canal formed by
the inrolled edges of the ventral surface is cylin-
drical, 0.2 mm. in diameter. The outer dorsal
surface is covered with spinous prominences. The
5–6 testes lie directly behind the ventral sucker,
and open at the forward end of the ventral canal
by a simple duct without a cirrus.
PLATE II.

FASCIOLA MAGNA.

These figures are reproduced from Bulletin 18, of the Texas Experiment Station. They are very kindly loaned by the author, Dr. Francis, for use in this report.

Figs. 14–16, photographs from preparations double natural size. One can distinguish the oral and ventral suckers, the dark area occupied by the uterus, and the complicated branchings of the alimentary canal. Compare with Plate I., figures 5 and 13 illustrating the structure of *F. hepatica*.
The female is cylindrical, much more elongated than the male, length up to 20 mm., thickness 0.2 mm. Suckers, as well as anterior body region, poorly developed. Eggs 0.12 mm. long, 0.04 mm. wide, with a lateral or terminal spine, but no cover.

The human blood fluke has been found in one of the monkeys, also, and a nearly related species occupies a similar place and gives rise to similar disorders in cattle. The native home of this genus is Africa, where it is found from Egypt to the Cape, and from the East to the West, on the coast, and in the interior. Exceptional cases have been reported in southern Europe, but those afflicted had brought the parasite from Africa. Thus far it seems not to have obtained a footing in any other country. The adult worm inhabits the portal system, especially the splenic vein, and the plexus of the urinary organs and the rectum. The large numbers of blood corpuscles found in the intestine of the parasite show that it lives from the blood into which also the eggs are laid in enormous numbers. They accumulate in the capillaries of various organs, such as the liver or lungs, and give rise to pathological changes of a severe character. The inflamed vessels are ruptured, and masses of eggs are set free. If this happens in the intestine a kind of dysentery is produced. More commonly it is in connection with the kidney, and so-called bloody urine results. The disease is so common that in some regions half the population are sufferers. Its termination depends directly on the degree of the infection.

The genus Amphistoma differs from the distomees in that the two suckers are located one at either end, and a ventral sucker is wanting. A single species of the genus may be mentioned briefly.

The Conical Amphistome—Amphistoma conicum (Zed.) Rud. 1809.
Syn.—Festucaria cervi Zeder 1792; Fasciola elaphi Gmelin 1789; Monostoma conicum Zeder 1800.

Body 10 to 13 mm. long, 2 to 3 mm. wide, ovoid, narrow in front and increasing toward the posterior end, slightly curved on ventral face. Eggs 0.16x0.09 mm.

This species is parasitic in the rumen of cattle and sheep in India and Australia. It lives among the large villi of the stomach attached by the posterior sucker. Its effect on the host is uncertain, and its life history unknown. It has been found in Canada by Wright, but has not yet been reported from the United States.

Order II.—CESTODES, OR TAPEWORMS.

Elongated flat worms, always segmented, at least internally, without alimentary canal and with organs of fixation, as suckers or hooks, at the anterior end. All are endoparasites.

This group includes a large number of forms, many of extreme importance. The body is characteristically ribbon-like and frequently shows externally its division into "links," segments, or proglottids, a division which is always more indistinct near the head and most evident at the posterior end of the body. In some cases these divisions cannot be seen externally, but may be
detected by examining the internal structure. The so-called head is a bulb-like enlargement of one end of the ribbon-shaped body which bears a group of suckers and sometimes a crown of hooks by which the worms maintain their position in the alimentary canal. Without exception these forms are internal parasites, and the adult lies extended in some part of the alimentary canal, a connecting duct, or, rarely, in the body cavity of the host. The immature stage is found usually in a resting condition, encysted in some organ of another host. The life history is complicated and in many cases unknown.

The considerable similarity in external appearance and the extreme variability of the muscular body, which, like the Trematodes, has no hard skeletal parts, renders confusion in determining species very likely. This has resulted in the description of the same species under many different names, as a glance at the lists of parasites will show. It has also led to the enormous increase in the number of species in the genus *Tænia* until there were included under that name, forms with a certain similarity of external appearance to be sure, but so unlike, not only in internal structure, but also in hosts and life-history that they are certainly only distantly related. The division of the old genus *Tænia* was first logically entered upon by Leuckart, and his work has been added to by R. Blanchard, Railliet and Stiles. In this summary, I have adopted the system given by Railliet in his Medical and Agricultural Zoology, with slight additions and changes.

The family of the *Tæniidae* is characterized by a head armed with four suckers, by segments distinctly separated and by genital orifices situated at the edges of the segments.

The mutual relations of longitudinal nerve, excretory ducts, and sexual canals afford a reliable basis for the distinguishing of genera and subgenera in this family, as was shown by Stiles in a recent paper. This author gives a key representing the approximate relationships of the forms; since it may be of use to those who undertake an extended study of the group it is given here:

I. Scolex in most cases with hooks; uterus having a median trunk with lateral branches; vitellaria simple, median: genital pore single; dorsal vessel narrower than the ventral and dorso-median to the latter; no circular commissure; eggs without pyriform apparatus............*Tænia* s. st.

A. Genital ducts pass on the ventral side of the nerve and of the two longitudinal vessels; dorsal vessels surrounded by two branches of the transverse commissure.................................*T. crassicollis*.

B. Genital ducts pass between the dorsal and ventral longitudinal vessels.
   a. Nerve on dorsal side of genital ducts........*T. solium* and *T. saginata*.
   b. Nerve on ventral side of the genital ducts......................*T. serrata*.

II. Scolex without hooks; one or two transverse uteri present; one or two genital pores and vitellaria, the latter never median; genital ducts pass to the dorsal side of the nerve; eggs with pyriform apparatus.

A. One transverse uterus present.
   a. Uterus with simple dilatations; genital ducts dorsal to two longitudinal vessels; dorsal vessel between nerve and ventral vessel; two genital pores like.................................*T. marmotæ*.
b. Uterus with ascon-spore-like egg sacs; pyriform apparatus without horns; genital ducts between dorsal and ventral longitudinal vessels..........................Thysanosoma.

B. Two uteri and two genital pores present; horns of pyriform apparatus well developed; genital ducts pass to the dorsal side of dorsal and ventral vessels........................................Moniezia.

C. Uterus single or double without ascon-spore-like egg sacs; eggs with single shell; genital pores irregularly alternate; strobila narrow; testes absent from median portion of median field......................Stilesia.

III. All four longitudinal vessels well developed and connected by a circular commissure; nerve passes to the dorsal side of the genital ducts; only one genital pore in each segment, two lateral elongated vitellaria.

.................................................................Ichthyotænia.

The peculiar position of Tænia maimotæ in the above key goes to show that it will probably prove to be the representative of a new genus when it shall be carefully studied. The genus Ichthyotænia contains only fish parasites, and will not be considered, but the others are discussed in detail in the following pages.

SUB-FAMILY. CYSTOTÆNÆ.—The body is large and the head almost always provided with a double or triple row of hooks. The ripe segments are longer than broad with a median longitudinal uterus having lateral branches. Eggs provided with a double envelope and the larva a Cysticercus or "bladder worm" of large size enclosing a considerable amount of fluid. The known hosts of both larva and adult are mammals.

The single genus of this sub-family is the now restricted group under the old name Tænia. It includes the two most common human tape-worms, one of which may well serve as type for the genus.

The Beef Tape-Worm, Tænia saginata Goeze 1782.

SYN.—T. mediocanellata Küchelum. 1852; Tæniarhynchus mediocanellatus Weinland 1858; T. inermis Moq. Tand. 1860.

Total length 4 to 8 m.; 12 to 1300 proglottids; the head is 1.5 to 2 mm. thick and without hooks; in the middle in front a shallow depression around which are four strong suckers, 0.8 mm. in diameter and surrounded often by a border of granulated black pigment. Neck 1 to 1.5 mm. long, half as wide as the head; proglottids broadest at the middle, where they measure 12 to 14 mm. in width. Towards the end they become longer and narrower, and the terminal segments are thick, melon-seed-shaped, and measure 18 to 20 mm. in length by only 5 to 7 mm. in width. The uterus is distinguished by the number of lateral branches, 20 to 30, which lie close together and branch dichotomously. Eggs oval 30 to 40 µ long, 20 to 30 µ wide, surrounded usually with the vitelline membrane.

This Tænia, which is also known as the unarmed human tape-worm, inhabits the small intestine of man. The larva is Cysticercus bovis of the muscles and viscera of cattle. The cosmopolitan character of both hosts are sufficient to show that the worm is distributed over the entire earth. It is also noticeable that this species is growing steadily more common, while the other human
Tænia, the species next to be described, is becoming rarer. Railliet quotes interesting tables to show this increase in the beef tape-worm in France.

The statistics of maritime hospitals give the following number of men infected with tape-worm among those admitted in the six five-year periods between 1860 and 1890.

<table>
<thead>
<tr>
<th>Period</th>
<th>Number of Infections</th>
<th>Infection Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>1861 to 1865</td>
<td>33 in 130,927</td>
<td>0.20 per 1,000</td>
</tr>
<tr>
<td>1866 to 1870</td>
<td>95 &quot; 152,822</td>
<td>0.62 &quot;</td>
</tr>
<tr>
<td>1871 to 1875</td>
<td>422 &quot; 137,361</td>
<td>3.06 &quot;</td>
</tr>
<tr>
<td>1876 to 1880</td>
<td>1,108 &quot; 130,898</td>
<td>8.45 &quot;</td>
</tr>
<tr>
<td>1881 to 1885</td>
<td>1,565 &quot; 155,616</td>
<td>10.05 &quot;</td>
</tr>
<tr>
<td>1886 to 1890</td>
<td>2,253 &quot; 152,352</td>
<td>14.80 &quot;</td>
</tr>
</tbody>
</table>

This increase, which is both constant and rapid, is due to the increased consumption of rare beef, which permits the introduction of the larva into the system while yet alive.

**Structure.**—The head (Fig. 8) of this tape-worm is of considerable size, and varies somewhat in shape, according to the amount of extension or contraction. These same conditions govern a still greater amount of variation in the neck, as the slimmer, unsegmented portion directly behind the head is called. If the neck is stretched the head appears pear-shaped, if the former is contracted, the head is a little more than a slight enlargement at its end. By far the largest part of the head is occupied by the four muscular suckers, which often project considerably and always show prominently their thick muscular walls. The center of the head in front of the suckers is occupied by the four muscular suckers, which often project considerably and always show prominently their thick muscular walls. The center of the head in front of the suckers is occupied by the fleshy projection, the so-called rostellum. It is shaped like a shallow saucer with elevated margin, and is in all respects like the corresponding structure of the armed tape-worm, save that it has no hooks. One nearly constant and characteristic feature of the beef Tænia is the considerable amount of pigment in the head. This is usually collected in the vicinity of the suckers, forming a dark colored ring or background to them.

As a special variety of this species there has been described from the south a form entirely covered by this black pigment.

Almost the entire mass of the first part of the body is made up of muscles and loose connective tissue in which the sexual organs are developed in older segments. Two systems deserve, however, on account of their importance in the determination of species, special mention; these are the nervous and the ex-
cretory systems. The center of the nervous system is a ganglionic mass, or "brain," in the head; from this longitudinal nerve stems, one near each side of the chain of proglottids, extend to the posterior end of the body. The main stems of the excretory system consist of a ring vessel in the head, and two, or four, longitudinal stems (C, Fig. 9), which run backwards near the nerves (N), and, joining together in the terminal segment, open outwards at the posterior tip of the body. At the posterior edge of each segment the longitudinal excretory trunks are joined by a cross vessel. The finer details of these two systems are not essential for our purpose. The relative position of nerve and excretory trunks serves as a means of distinguishing various genera of tape-worms.

The structure of the sexual organs is of such importance for the identification of species that they must be considered in detail. Segments which are about a foot or a foot and a half from the head are most favorable for this study. Here the organs of both sexes are well developed. They are best studied in specimens preserved as specified in Appendix A; yet fresh segments, cleaned in salt solution and compressed as directed for the study of flukes, give good results.

The structure of the sexual organs in this species is represented in the adjoining figure (Fig. 9).

Of the male organs the testes are seen as countless small round masses, which fill the entire width of the proglottid between the lateral excretory vessels, but are most numerous in the forward part and towards the sides of the segment. Fine ducts which lead from these organs, come together, and not far from the center of the proglottid form the beginning of the so-called *vas deferens*, a winding tube with prominent walls which extends directly towards the edge of the segment and ends with a conical muscular organ, known as the cirrus. This projects slightly into a cup-shaped depression on the side of the proglottid, into which the female organs also empty. This depression seems to project since its edge is pushed out beyond the level of the edge of the segment, and its opening
is often called the common sexual pore. These pores are not on the same side of the segments throughout the chain, but they alternate in general, although every chain will show numerous exceptions to the rule.

The female reproductive system begins with the long tube leading into the segment from the common genital pore where it opens a little behind the vas deferens of the male system. This long tube, which is known as the vagina, passes in toward the center of the proglottid nearly parallel with the vas deferens and makes a quarter circle towards the posterior part of the proglottid. Just after a small enlargement, or receptacle, in which the sperm is stored up, it enters a spherical gland—the so-called shell gland—at the edge of which it receives the oviduct. The two globular organs in the posterior half of the segment near the center are the two ovaries; they are connected by a cross duct, from the center of which the oviduct already mentioned passes back to join the vagina at the edge of the shell gland. In the center of the shell gland this duct is joined by a second canal the yolk duct coming from below, from the yolk or vitelline gland, an elongated, somewhat spindle-shaped organ in the extreme posterior portion of the proglottid. From the center of the shell gland the canal, formed as already described by the union of the yolk duct and oviduct, extends directly forward; at first small in diameter, as soon as it has passed the tube connecting the ovaries it expands into a cylindrical tube of some size which extends through the center of the segment and ends near its anterior limit. This tube is the uterus, as it is found in proglottids at this stage in development.

The process of fertilization is similar to that in the flukes already described. The egg cells arise in the ovary, pass back through the oviduct; in the shell gland each is fertilized by sperm from the receptacle and supplied with yolk from the yolk gland and a covering by the shell gland itself. Thus completed they are pushed on up into the uterus. As this has no opening they accumulate here and gradually bulge out the sides of the uterus until its simple cylindrical form is changed into a branched shape, which, growing larger and larger, at last fills up the entire proglottid. The proglottid is "ripe" and is detached from the chain to reach the exterior in the excrement. Since the identification of the worm at this time is a matter of some importance a more detailed description must be given of the single "ripe" proglottid, which will suffice alone for a diagnosis.

The segments of the beef tape worm are not only evacuated with the stool, but also leave the patient spontaneously. This is due to the prominent development of the musculature, which exhibits itself also in the movement of the segments long after they have left the intestine. Thus such segments have been found moving over the walls of a privy or even over the bed of the patient. The forward edge of the proglottid was weakened by the separation from the chain, and in these crawling movements the eggs are forced out of the uterus or branches and left here and there as the

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**Fig. 10.** Successive positions of ripe segments of *Famia saginata.* Natural size (Laboubene.)
proglottid wanders. Naturally in this movement the shape of the body undergoes considerable change. (Fig. 10.)

At this time the segments are very opaque and the shape of the uterus can be detected best after the addition of acetic acid or potash in solution, followed by pressure between two glass plates. Then the following details can be distinguished (Fig. 11): the median trunk of the uterus as a thick stem, reaching nearly to the forward end of the proglottid but stopping some distance short of the posterior end; on either side some twenty to thirty lateral branches, which are close together and which extend usually nearly to the edge of the segment. Most of them are branched, but so that at any point of branching the stem divides only into two parts. The sexual glands have disappeared entirely, and only on the side of the segment where the pore is located can one see traces of the vas deferens and vagina; where these are the uterus sends out no lateral branches, but otherwise the proglottid is entirely filled.

The changes from the condition of the segment at sexual maturity to the “ripe” proglottid with its mass of eggs has been produced gradually. During this time the eggs which have accumulated in the uterus are developing, and when the segments are set free they are in the condition shown in the figure where a thin yolk membrane surrounds an opaque oval shell, 0.03 mm. in diameter, within which can be found the embryo. The embryo is spherical and provided with three pairs of long hooks.

**Life and History.**—The feeding places of cattle are often soiled by human excrement; not infrequently the straw and manure in the cattle yard is similarly affected. In some places privy contents are used in fertilizing fields, and finally the method of emptying city sewerage into neighboring streams assures the wide distribution of tape worm segments and eggs. Taken into the stomach with food of one sort or another, the embryos escape from the shell there and bore their way through the wall of stomach or intestine by means of the three pairs of hooks. The exact method of their further wandering is unknown. Since so many make their way into the liver, it is probable that the portal circulation aids in their migration. Once settled in some suitable location, they begin to develop. They increase very rapidly from the original microscopic size and in two to three weeks have reached an average diameter of 0.5 mm. In four weeks the embryo, or *Cysticercus*, is 2.25 mm. in diameter, in ten 3.5 mm., in twenty 6 mm. by 4.5 mm., in thirty 8 to 9 mm. by 6 mm. This increase in size is accomplished in large part by the accumulation of a considerable amount of watery fluid in the center, making the cysticercus in fact a “bladder-worm,” as it is usually called in its later stages. In the third week, when the bladder has a diameter of 1 mm., a new stage begins; at one point in the circumference an increase in the tissue produces a thickening or projection.
which continually grows larger and projects further into the cavity of the bladder. At the same time a depression appears at the same point on the outer side of the bladder and grows into the projection. At the bottom of this depression, which is enlarged like a flask, there arise four suckers in reverse. This is the head of the future tape-worm, yet reversed like a glove finger turned inside out. The part behind the head continually increases in length; it is to become the neck of the tape-worm. The cysticercus (Fig. 12) has reached its full development and is ready for a transfer. It waits in this condition in the flesh of cattle until the meat is brought into the human stomach. The first occurrence may be brought about experimentally by loosening the cyst from its place in the flesh; freeing the cysticercus from the cyst and placing it in water of a temperature of 100° to 105° F. Then the head is reversed as if the muscles of the bladder contracted and forced it out. One can easily recognize now the four suckers and the depression between them so characteristic of the adult worm. The slender, unsegmented neck is also evident; on it hangs a bladder now much shrunken and folded.

In the stomach a similar process is carried on and the young tape-worm migrates into the small intestine. Here it fixes itself between the projections of the wall, near the beginning, and starts the last stage of its life history. In connection with growth in length comes the development of the sexual organs. The length of time necessary for the production of ripe proglottids is naturally not fixed. From nine to twelve weeks after the taking of the cysticercus ripe proglottids are given off. In one case a worm of 4.8 m. total length was brought away by medicine after 67 days; the worm had grown 72 mm. per day and had produced daily 13 to 14 segments.

Pathology.—Ordinarily but a single specimen of the beef tape-worm is found at one time in the intestine, but this cannot be taken as a rule, since two or three at once are not uncommon, and up to fifty are recorded. In spite of the absence of hooks this *Taenia* maintains its position very strongly by means of the powerful suckers. Cabbold records cases of continued existence of a worm in the intestine and constant giving off of proglottids for six, ten, or even eleven years!

The disturbances caused by the tape-worm in the intestine are partly local and partly general; disturbance of the digestive function and colic pains are in the first group; fainting spells, epileptic fits, and various nervous symptoms belong to the general troubles. These symptoms are, however, so general and so uncertain that a definite diagnosis must be made by finding proglottids or eggs—in which case also the species can be determined. The beef tape-worm is much less dangerous than the here fortunately rarer pork tape-worm, next to be described.

This is not the place to consider the various methods advocated for driving out the human tape-worm. Treatment of so violent a character should only
be advised and carried out by some physician; on the other hand some general preventive measures may properly be treated here. The cysticercus is killed by a temperature of 115° to 118° F.; it is, however, clear that all parts of the meat would be raised to that point only on prolonged cooking; and to those who enjoy steak or roast beef rare this is an unwelcome rule. The real fault lies one step further back; but to consider it properly let us first inquire into the prevalence of the Cysticercus bovis among cattle.

The cysticercus lies in connective tissue between muscle fibres and gives rise to that condition of the beef which is commonly known as "measles." The favorite seat of the bladder-worms seems to be the jaw-muscles (pterygoid external and internal.) Out of 390 infected beeves found at Berlin, Germany, in 1890, 360 had the parasite only in these muscles and only 22 could be said to be generally infected.

In the nature of the case the herded animals could hardly be more than lightly infected and would display no such extreme symptoms as were called forth in the experiments of various German investigators who, as the result of feeding a considerable number of ripe proglottids to cattle, note rise in temperature and other serious symptoms followed by death, the result of the wanderings of the countless embryos. The lightly infected animal will show no such symptoms and the irritation and loss due to the presence of the parasite are very small. Yet the quality of the meat and its desirability for certain purposes at least are very seriously impaired.

Why need cattle become infected with the "bladder-worm" at all? Especially in the western states where the land is broad and yet unpolluted by sewage, is it true that the infection of cattle can only result from the grossest carelessness and disregard of proper sanitary rules. If the herders are not infected with the adult worm and if pains be taken to keep the human excrement away from land used for pasture or for confining stock, every condition favors the raising of untainted animals. If, however, the owner does not have regard to the sanitary condition of pasture land and yards, the result will certainly be the infection of the stock. The question of pure food has been the subject of extensive legislation during the last few years and will demand even more attention in the future; and one of its foremost considerations is good meat.

**The Pork Tape-worm, Tænia solium (L.) Rud. 1810.**

*Syn.—T. pellicuda Goeze 1782.*

Length 2 to 3.5 m. Number of proglottid 800 to 900, of which about 100 are ripe; these make, however, one-third the total length. The head is spherical, 0.6 to 1. mm. thick, with a double crown of usually 26 to 28 hooks, alternating larger and smaller, and four suckers, 0.4 to 0.5 mm. in diameter. The neck is filiform, about 10 mm. long. First segments very short, 1 m. from the head square; at the posterior end the ripe proglottids are 10-12 mm. long and 5-6 mm. broad. The uterus of the ripe proglottids has a median stem with 7 to 10 lateral branches, which are heavy, well separated from each other and branched. Eggs 31 to 36 μ in diameter.

This, which is also known as the armed human tape-worm, inhabits in the adult condition the small intestines in man. The larvae is known as *Cysticercus*
cellulosi and is found encysted in the muscles and viscera of the pig ordinarily, but also of man, dog, cat, rat, deer and ape. It seems to be distributed over the entire world with man and the pig; among those people who do not use pork it is not found, as it is also wanting in torrid regions. It is most common in those places where pork, especially if eaten uncooked, is highly esteemed. Contrary to the statement of various European writers it is very uncommon in the United States. The records of meat examination among some continental peoples give a basis for estimating the frequency of the Cysticercus cellulosae which is thus found to occur in Prussia in 1 hog out of 340, in Austria 1 out of 307, at Turin 1 in 250, at Milan 1 in 70. Leuckart has estimated, however that on the average of Germany 2 to 3 hogs in 100 are infected.

STRUCTURE.—In contrast with the beef tape-worm, it may be noted that the head (Fig. 13-14) is smaller and the projection in the center is more prominent as well as armed with a double row of hooks. The points of the hooks lie to be sure in a circle, but they alternate in size, a larger and a smaller, and the points of attachment form two lines. The form of the hooks differs as well as the size; and the differences are evident on examination of the figure. (Fig. 15.)

The size of the proglottids which are sexually mature is noticeably less than those of Tænia saginata. They measure not more than 4.5 to 5 mm. in width by 2.5 to 3 mm. in length. Such a proglottid examined in the manner indicated for the beef tape-worm shows the same organs in much the same relation, yet characteristic differences exist sufficient to distinguish clearly this species from the other. The most apparent of these (Fig. 16) is the unequal size of the two ovaries, that on the side of the genital pore being markedly smaller than the other and oval rather than spherical. In addition to this there is a small organ, in appearance like the ovary, which lies in the angle between the vagina and the uterus; it is in fact a diminutive lobe of the ovary, as if the vagina in its course had cut off the corner of the ovary past which it runs. This is a constant and reliable peculiarity of the species. Less striking, though equally constant, is the compressed form of the organs when compared with Tænia saginata, as it is clearly seen in the much flattened yolk gland at the posterior edge of the proglottid.
In the ripe segment differences between this species and the beef tape-worm are no less characteristic. It is in general true that the proglottids are not given off separately, but in sets of two or three. They are also thinner, weaker, and in general smaller (compare Figs. 11 and 17) and more transparent; but these are relative characters and consequently somewhat deceitful. It is the form of the uterus (Fig. 17) which gives the proglottids a decisive character. In general the lesser number of lateral branches and the looser arrangement of the system as a whole, as well as the heavier, thicker appearance of the separate parts in this species make confusion unlikely. There are only seven to nine lateral branches, which are more heavily and unevenly branched and not infrequently enlarged at the end like a club. The movements of the free segments (Fig. 18) are both slower and also weaker than those of T. saginata.

LIFE HISTORY.—The eggs resemble very closely those of the beef tape-worm, being only more nearly spherical; they enclose a six-hooked embryo of exactly similar appearance to those of T. saginata. No evidence is at hand on the way in which the embryo reach their resting place from the intestine. It is evident that the usually more carelessly kept swine run greater risks of infection than the cleaner cattle, and what was said of the probable method of infection of the latter with the embryo of the beef tape-worm applies with double force to the hog. The development of the embryo of T. solium does not seem to be so rapid as that of T. saginata; for the former has reached in eight days, the youngest known, a size of only 0.033 by 0.024 mm. At the end of three weeks they are 0.8 mm in diameter, and in thirty-two days from 1 to 6 mm. by 0.7 to 2.5 mm. Even in the smallest bladder-worms mentioned the head projection could be seen, and in those of three weeks old the neck has grown so long as to be crooked like an “L.” In the second and third month the suckers and hooks are formed and further development is in the portion
between head and bladder—a part which, growing constantly larger and larger, compels a further twisting so as to produce often a complete circle and half of a second. Yet it is highly probable that before the close of the third month the pork bladder-worm is ripe and capable of being transferred successfully.

Though man is the only host of the adult worm it is possible to bring the bladder-worm to a partial development in other animals, such as the rabbit, and the experiments show that both the bladder and the long worm-like portion which has developed between bladder and head are lost and only the head with a short thin “neck” remain to form the starting point of the new worm. Experiments show that from eleven to twelve weeks are necessary to bring the worm to full development in the intestine and to cause evacuation of proglottids.

Pathology.—The pork tape-worm gives rise to conditions in the human intestine not unlike those caused by Taenia saginata and already described. In keeping with the smaller size and less active movements of the worm the nutritive and nervous disturbances are less marked than in the case of the beef tape-worm. Were it not for another character it would be a less dangerous guest, for it has in spite of the crown of hooks a less powerful hold in the intestine than the beef tape-worm. The peculiarity which makes it far more to be feared is the ability of the cysticercus to develop in the human body just as well as in the pig. Since the Cysticercus cellulosae, the bladder worm of the beef Taenia, probably never develops in the human system, the pork Taenia is, in spite of the less disturbance in the intestine, a far more dangerous species, for the proglottids and eggs which are discharged by the patient are a source of danger to himself and his surroundings so great that Leuckart says the removal of the worm should be regulated by law since the host of a Taenia solium is a menace to all who are brought in contact with him.

In hogs experimentally infected by being fed ripe proglottids, as many as 80,000 cysticerci have been found in the flesh; in those which are accidentally infected the number is not over 20,000, or about fifty to every ounce! The cysticerci are most common in the breast and shoulder muscles, tongue, and hams. In regard to the effect of the introduction of the embryos into the hog and subsequent disturbances, it may be said that it depends so greatly upon the number rather than the conditions, that no positive statement can be made. In the extreme case, however, the animal suffers definite cachexia and ultimately death. The condition of the muscles with the bladder-worm is known as “measles,” and “measly” pork is then the means of introducing the tape-worm into the human system.
But the bladder-worm, as well as the adult *Taenia*, are at home in the human body, and the infection with the embryos demands some explanation. Of course, the most immediate method is by the transfer of eggs from some infected person, and it needs hardly be said that the percentage of infection stands directly in proportion to the care and cleanliness of various regions and families, though, of course, accidental introduction of eggs in drinking water, on vegetables, etc., must not be forgotten. Self-infection is also extremely probable, and it is by no means necessary that the introduction of the eggs take place through the mouth. If any digestive disturbances exist by which the ripe proglottids can be carried back from the intestine into the stomach by reversed movements of the intestine, the substance of the segments would be destroyed by the stomach juices and the embryos set free to wander out into the body. It will of course be rare that this reverse action takes place in such a way that the proglottids remain in the stomach to be digested, for ordinarily the reverse movement continues and the contents of the stomach are also ejected from the body. Numerous cases of the vomiting of proglottids are known.

So much is certain: the infection with the cysticercus is most dangerous for the host of the adult worm and those who brought it in regular contact with him. The pathological conditions brought about by the *Cysticercus cellulosae* vary greatly with its seat. In the subdermal tissue or body muscles no appreciable harm is caused by one or even a few. In the heart muscles their presence is more to be feared and the exact location will determine the nature of the trouble caused by them. Dangerous functional disturbances and pathological changes are due to their lodgment in the eye, as is not uncommon, and finally the brain bladder-worms are the cause of extreme symptoms of nervous disorder which vary greatly in the special case. Enough has been said to show the dangerous character of this human tape-worm and of the necessity of guarding against such an unwelcome guest.

TREATMENT.—What was said with reference to *Taenia saginata* applies equally well here. Treatment should not be undertaken except under the advice and direction of an experienced physician. Fortunately the habit of eating raw or rare pork is very seldom met among us in the United States and hence no doubt the comparative infrequency of the pork tape-worm. The real precaution should be on the part of the swine breeder that his hogs do not become infected and hence are not in condition to spread the infection. On this point Leuckart says: “It is not alone the distribution and abundance of the tape-worm which is the decisive element in the question, but in much higher degree the care and nourishment of the swine. * * * As a matter of fact the introduction of stall feeding is said to have reduced the bladder-worm sickness noticeably in many places. A favorable result is, however, only to be expected when the swine are at the same time kept decently clean and have no access to dung heaps and privy waste which are both to a certain degree suspicious. The food also must naturally be kept from any sort of contact with human excrement and any tape-worm patient must be at once removed from all contact with the swine or
from the vicinity." What keen censure his remarks contain on the methods adopted by some breeders, not only in Germany, but here among us in the United States; and who has not seen pig pens which could hardly be called "decently" dirty!

**The Margined Tænia.**—*Tænia marginata* Batsch 1786.

**Syn.**—*Tænia e cysticerco tenuicollae* Kuchenm. 1853.

The largest of the Tænias of the dog; length 1.5 to 3 m. Head quadrangular, 1 mm. in diameter. Suckers weaker and smaller than in *T. solium*, hooks of much the same size, but slimmer, 32 to 42 in number, usually 36 to 38. Neck but little thinner than the head. Proglottids evident close behind the head; they increase in width gradually, becoming quadratic 50 to 60 cm. behind the head. The posterior edge of the proglottid projects and shows a wavy outline. The last segments measure 4 to 5 mm. wide, by 9 to 11 mm. long. Uterus with short median stem and few (at most 8)

Fig. 19.—*Tænia marginata*, natural size: *A*, large hook; *B*, small hook; *A* and *B* magnified 250 times. [After Railliet.]

lateral branches which are themselves supplied with strong branches reaching far forward and back. Eggs round, 0.031 to 0.036 mm. in diameter.

This *Tænia* (Fig. 19.) lives in the small intestine of the dog and wolf. It is by far the largest of the canine tape worms and is but little smaller than the pork tape-worm of man for which it has been often mistaken. Its larva is
known as *Cysticercus tenuicollis* (Fig. 20), it lives singly or in groups in the omentum, liver and other viscera of ruminants and swine. It is particularly characterized by the enormous caudal vesicle which reaches a size of 160 mm. in length by 60 to 70 mm. in width. The neck is long and thin and the head minute in comparison with this enormous bladder worm. Ten to twelve weeks suffice for the development of the adult and for the expulsion of ripe proglottids.

**PATHOLOGY.**—In Europe this *Taenia* is very common in the dog being varyingly present in from 73 per cent in Iceland to 5 per cent at Lyons, France, of the animals examined. More important is the bladder-worm found in cattle, sheep and goats. It is present ordinarily in small numbers but if one of these swallows at once a fragment of the *Taenia* recently voided by a dog, the emigration of the larva to liver and peritoneum gives rise to hepatic hemorrhage, terminating fatally in many cases. Though frequently classed as a parasite of man, the statement rests on a misquotation, and in spite of the close intimacy of man and dog in Iceland, where the parasite is very common, it has never been found in the human system as adult or larva.

**The Serrate Tape-Worm, Taenia serrata** Goeze 1782. (Fig. 21.)

Total length 50 to 100 cm.; head large, approximately spherical, 1.3 mm. in diameter, armed with a double crown of 38 to 48 hooks (Fig. 22). Neck slightly smaller than the head, 1 to 3 mm. long. Proglottids at first very narrow, becoming quadrate at 20 to 25 mm. behind the head, ripe proglottids 10 to 12 mm. long, 4 to 5 mm. broad. Anterior edge of the proglottids narrower than the posterior whereby the chain appears serrate ("saw-toothed"); uterus, with long median stem, having on each side 8 to 10 lateral branches, themselves abundantly and irregularly branched. Eggs 0.036 to 0.040 mm. long, by 0.031 to 0.036 mm. wide.

*Taenia serrata* lives in the small intestine of the dog in company with the last species, with which it is often confused. It may be easily distinguished, however, by the form of the uterus (Fig. 23), as well as by the forms of the hooks (Fig. 22). These are at least a third longer and stronger than in *T. marginata* (Fig. 19). Both the head and the suckers are also larger in this species. The larva is *Cysticercus pisiformis* Zeder, which is found in the peritoneum of the rabbit and hare. It is widely distributed, and is not uncommon in rabbits in Lincoln.

**PATHOLOGY.**—In northern Europe it seems to be rare, only one dog in 500 at Copenhagen being infected with this species; in France it is much more com-
The Thick-Necked Tænia, Tænia crassicollis Rud. 1810.

Total length 15 to 60 cm. Head hemispherical 1.5 to 1.7 mm. in diameter, with a double row of 29 to 52 hooks (Fig. 24). Neck indistinct, as broad or broader than the head. Ripe proglottids 8 to 10 mm. long by 5 to 6 mm. wide, with projecting corners. Eggs spherical 0.031 to 0.037 mm. in diameter.
This parasite lives in the small intestine of the house cat and numerous wild species. Its bladder-worm, the *Cysticerus fasciolaris*, is found in the liver of the rat, mouse, and wild species of the genus. In appearance this bladder-worm is very peculiar; the vesicle is very poorly developed, while the body is long and divided into segments; it varies in total length from 3 to 20 cm. and more. Curiously enough the entire body is lost when the larva is brought into the stomach of the cat, and only the head survives to attach itself in the intestine and to develop anew the *Taenia*.

**Pathology.**—The worm is not infrequently present in large numbers in the intestine of the cat, and especially after invasions of rat armies have caused veritable epizootics among the cats, giving rise to inflammation, fatal in some cases. Zschokke records its occurrence also in the stomach, where it causes severe gastritis.

I have collected both larval and adult worms in Lincoln, where they seem very common.

**The “Gid” Tape Worm, *Taenia caninus* Küchenm. 1853.** (Fig. 25.)

Total length 40 to 60 cm. Head pear-shaped, small, 0.8 mm. in diameter, armed with a double row of 28 to 32 hooks (Fig. 26). Neck long, slimmer than the head; proglottids narrow, square at 15 to 20 cm. from the head; ripe segments, slightly elliptical, 8 to 12 mm. long, 3 to 4 mm. wide. Uterus with median stem, and 20 to 25 branches on either side, which are nearly parallel, simple, and not long. Eggs spherical, 0.031 to 0.036 mm. in diameter.

The “gid” tape-worm lives in the latter portion of the small intestine of the dog. Its bladder-worm, known as *caninus cerebra* Rud., undergoes its development in the brain or spinal cord of the sheep ordinarily, but also less commonly of cattle, horse, and numerous wild herbivorous mammals.

**Life History.**—If ripe segments of the tape-worm are fed to a lamb the six-hooked embryos become free, penetrate the walls of the intestine, and are taken no doubt by the circulation to the various organs. In some, as the lungs, liver, or heart, development goes on to a certain period, then ceases, and the embryo perishes. On the other hand, those which reach the brain or spinal cord find conditions under which they continue to develop. Here they grow in two to three weeks to a
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Diameter of 0.6 to 3 mm. The first indication of a head comes at about five to six weeks, and full development is reached in two to three months. They are then bladders, varying from the size of a cherry to that of a hen's egg. (Fig. 27). The wall is then translucent and covered with little white spots in irregular groups. These spots represent each a tapeworm head, and the total number may be 500. When introduced into the intestine of a dog the various heads may each give rise to a tapeworm. The development of the adult is rapid. Leuckart says that ripe segments are found in from three to four weeks. It is ordinarily true that only a certain number of the heads actually develop, the weaker going to pieces.

Pathology.—The adult worm lives commonly in shepherd dogs in considerable numbers, varying from a dozen to two hundred. The disturbance to the dog is, however, in most cases, insufficient to attract attention. With the larva, Cœnurus cerebralis, the matter stands very differently. While the embryos are active and passing through the tissues, the sheep show only in severe cases signs of disease. Later on symptoms are aggravated by two causes—irritation and pressure connected with the growth of the Cœnurus. The peculiar actions of the sheep give to the disease its name of "gid," or "staggerers," and the symptoms can hardly be mistaken. Death occurs in six week from the appearance of these symptoms. The only danger of confusion lies in the disease known as "false gid," which is caused by the larvae of Oestrus ovis, or "grub-in-the-head." In this case symptoms of catarrh are present and there is less of the turning which is characteristic of the true gid.

Treatment.—A method of cure is here as before difficult to suggest. The process of trephining, i.e., of removing a portion of the skull and then puncturing the bladder has been advocated. The operation is, however, one which requires considerable skill and its success somewhat uncertain. Furthermore the impossibility of such a plan when the flock to be treated is of considerable size needs no further explanation. It will be probably more practicable in all cases, save those of extremely valuable stock, to kill the animals affected.
In this case preventive treatment is not only possible but involves no difficulties at all beyond the careful and precise observations of the rules laid down. The heads of sheep which are slaughtered or which have died should not be left where the dogs can have access to them. They should be boiled or burned. The same holds true of the viscera. At the same time the dogs should be regularly and carefully treated for worms so that the pasture ground be not infected by their droppings. The treatment and handling of the dogs may well be the same as that recommended for *Taenia marginata*. If the dogs are kept free from the adult tapeworm, the flock cannot become infected with the "gid;" and the stock raiser cannot afford to have his dogs infected, not only on account of this species, but also on account of those already described and because of the next species which is even more dangerous. It is advice which cannot be too often repeated.—*Keep the dogs free from tape-worms.*

**Taenia echinococcus** v. Siebold 1853.

**Syn.**—*Echinococcifer echinococcus* Weinland 1861.

A minute tapeworm (Fig. 28), only 2.5 to 5 mm. long. Head small, 0.3 mm. in diameter, rostellum projecting, armed with thirty to forty hooks in a double row. The chain is composed of only three or four segments, of which the last alone is ripe and in size exceeds the rest of the body.

This tapeworm is at home in the beginning of the small intestine of the dog, where it is found in considerable numbers, even thousands at once. It has a wide distribution; in Iceland it is found in twenty-eight dogs out of 100; in Switzerland in four out of 100, and in France seven out of every 100 are thus infected. In Australia it is said to be very common, and in the United States it has been certainly reported but once or twice.

The larva or bladder worm is known as a hydatid, the *Echinococcus polymorphus* Dies., and undergoes its development in a great variety of host, as well as in almost any part of the body. Man, cattle, sheep, swine, dog, cat, horse, rabbit, and half a score of other forms are said to shelter it.

**Life History.**—The experiments of Leuckart and others have placed the connection between the tapeworm and the hydatid beyond question. Sheep seem to be the most favorable animals for experiments. In one case the sheep was examined four weeks after being fed with the ripe segments of the tapeworm. In the midst of small nodules on the surface of the liver were spherical bodies of 0.25 mm. in diameter with a clear capsule and granular contents. In the case of those killed at two months the hydatids were double this size and had begun to collect a watery fluid. In nineteen weeks the hydatids had grown to a diameter of 10 mm., but in spite of the size no trace of a head could be seen. When the hydatid has reached a diameter of 15 to 20 mm., the heads arise in considerable numbers on the inner layer of the hydatid, not directly, but within brood capsules or prolig
Fig. 29.—*Echinococcus polymorphus*: diagrammatic, ct, cuticula or hydatid membrane; m, inner or germinal membrane; vf, secondary vesicle in formation; vfl, the same in the interior of the bladder; vpe, external secondary vesicles; vp, proligorous vesicles; vpf, internal tertiary bladders; vplc, external tertiary bladder. [After Rabllet.]

The hydatid has then developed on its inner surface in these numerous brood capsules countless heads which, under favorable conditions, will develop into as many tapeworms. But this is not all. Secondary or daughter bladders (vf, Fig. 29) may develop and become separated from the original *Echinococcus*, either on the outer surface or on the inner (vfl), and these may give rise to tertiary bladders (vpf), etc., until the mass of the whole has come to be very great and its weight even to thirty or forty pounds. It should be mentioned that either the primary or secondary bladders may remain sterile, i.e., without heads.

A form of the *Echinococcus* which deserves especial mention is the *E. multilocularis*; this is rarely found in cattle and swine, but almost exclusively in man, and generally in the liver. It was formerly regarded as a tumor, and consists of numerous groups of bladders embedded in a common stroma. When cut small cavities are found irregular in form, and filled with a transparent gelatinous substance. The nature of this structure was first demonstrated by Virchow, who showed the mass were caused by a continued external proliferation of an *Echinococcus*; the beginning of such a process is indicated at the right of Fig. 29; occasional heads or hooks serve to demonstrate the nature of the structure.

Pathology.—Among all the human parasites this enjoys the widest range of location, and not an organ is free from its visits. Generally only one or a few bladders at most are found, and then (near each other) in the same or neighboring organs; and commonly the liver (Fig. 30) is the most frequented
organ. The *Echinococcus* bladders have the power of proliferation, and may
give rise to nests and series of bladders. The growth is slow, as already noted,
in connection with the life history, and variable in different cases. Furthermore,
the form and character of the organ invaded exercise a great influence
on the growth of the parasite. It is occasionally true that the increase in size
goes on for thirty or forty years before an operation is necessary to remove
the hydatid; but generally a much shorter time, some two to six years, is sufficient
to cause the death of the host. The limit of the disease depends also
even more on the organ invaded and the exact locality; the more vital the
organ and the closer the relation of the hydatid to the large blood vessels, for
instance, the more serious the case and the quicker its termination.

It is evident that so long as the *Echinococcus* is small, the disturbances are
so minor as to attract little attention, but with the growth and accompanying
pressure come functional disturbances of the severest character. The exact
nature of these varies with each case according to the exact location of the
parasite and the direction of the pressure exerted by its growth. For the hu-
man hydatid no limit seems to be set to its size, and the ultimate resource lies
in the surgeon’s knife. When one considers the method of growth and the size
reached before the malady becomes evident, it is not at all strange that the
destruction of organ substance and the intimate relation of vessels make the
operation difficult and dangerous. In Germany only fifty percent of the opera-
tions result successfully. It may well be doubted if any known parasite is so
much to be dreaded as the *Echinococcus*, and it is by no means welcome news
that this form is now beyond a doubt in our own country. Exact reports as to
its present distribution are entirely wanting, and the attention of the proper authorities should be turned to the subject that if possible the parasite may be wholly rooted out.

In addition to those already described in the foregoing a couple of other species of tapeworms are found in dogs. For convenience in determining these species I give here a table taken from Neumann (p. 448).

"The eight species of tapeworm, a summary description of which has just been given, are sometimes difficult to distinguish from each other—the first five especially. If T. Krabbei be excepted—because it is not likely to be observed in our country, as it has its origin in Reindeer—an exact determination may easily be arrived at by referring to the following table:

<table>
<thead>
<tr>
<th>Species</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>T. serrata</td>
<td>230μ to 260μ long; genital pores very salient</td>
</tr>
<tr>
<td>T. serialis</td>
<td>136μ to 157μ long; genital pore not very salient</td>
</tr>
<tr>
<td>T. marginata</td>
<td>180μ to 220μ; length of mature segments double that of their width</td>
</tr>
<tr>
<td>T. echinococcus</td>
<td>150 μ to 170 μ; length of the mature segments treble their width</td>
</tr>
<tr>
<td>Dipylidium caninum</td>
<td>Head unarmed; sexual orifices on the ventral surface</td>
</tr>
<tr>
<td>Mesocestoides lineatus</td>
<td>Double and bilateral</td>
</tr>
</tbody>
</table>

When one considers the character of these worms and the diseases they may spread among men and the domestic animals it will be evident that a strict control over the sanitary condition of the dog should be exercised by every owner, and it may well be asked whether the removal of a few hundred thousand of the stray curs which abound in all parts of our country would not be a sanitary measure of great value. It requires no explanation to show that the vagrants are the very ones most likely, by virtue of their omnivorous habits, to become infected, and, on account of their nomadic life, to carry the parasites from place to place.

Often it seems that the tapeworm has no effect on the health of the dog; on the other hand, Taeniasis may produce symptoms of intestinal troubles and even at times nervous symptoms also akin to those caused by rabies.

The presence of the tapeworm may be recognized usually by the segments voided with the faeces. Their removal is on all accounts to be desired and their presence in farm or pet dogs should not be endured for a day. After reviewing many cases in detail, Neumann gives the following recommendations and remedies (p. 453):
The tapeworms are not therefore absolutely free from inconvenience to the dog, and it is advisable to free that animal from them, in order to prevent accidents which they might occasion; and this is more to be urged in view of the possible infestation of man and the domesticated herbivora by the bladder worm issuing from these *Taenia*. This recommendation is particularly applicable to sheep dogs that go among grazing flocks, and to those which—rare in this country—live in such close companionship with man that the proglottides expelled along with their excrements may not contaminate the water he consumes.

"The administration of *täniafuge* should be prepared for by a fast for twenty-four hours; enemas may also be useful.

"Many *täniafuges* have been proposed and employed.

"The aethereal extract of male shield-fern is certainly one of the best, and two to eight grammes in capsule or pill produces a prompt result. Trasbot states that remarkable effects are obtained by mixing the extract and the tincture—two to eight grammes and eighteen to forty grammes. But this preparation has the inconvenience of being very irritating to the intestine, and to require the addition of a large proportion of some excipient. An excellent mode of administration is that practiced at the Toulouse clinic. The dose varies according to the weight of the animal—about fifteen grammes for a setter—and is mixed with a quantity of castor-oil, which is also proportionate to the weight of the dog. The evacuation of the tapeworms is almost certain, and often takes place within an hour after the remedy has been administered.

"Trasbot also recommends birch seeds (*graine de bouleau*), given in milk for four or five days, in doses of 10 to 20 grammes, as an excellent and perfectly safe agent.

"The English more particularly employ calomel in doses of 0.25 to 1 gramm in a spoonful of syrup. Deladre-Blaine recommends oil of turpentine, 2 to 4 grammes, given in yolk of egg for some days.

"Kousso is particularly serviceable. It is given in doses of 10 to 30 grammes the flowers being pulverized and mixed with 35 grammes of sugar in some spoonful of infusion of tilieul; or the leaves are infused for a quarter of an hour in one-fourth of a litre of tepid water, and the whole is administered when the animal is fasting. An effect is produced in about two or three hours.

"Pomegranate bark is also efficacious, employed in doses of 50 to 150 grammes in decoction with 750 grammes of water, reduced to 500 grammes. Three doses of this are given at intervals of an hour. The fresh root is to be preferred as being more certain. Treatment is completed by the administration of a purgative—30 grammes of castor oil—three hours after the last dose.

"For twenty years kamala has held an important place among *täniafuges*, and it is also a purgative. It is given in 5 to 10 grammes in pill, and it may be useful to repeat the dose two or three days after. The seeds or nut of areca catechu in powder are a good *täniafuge* for the dog. They should not have been gathered for more than a year. They are given in doses 5 to 10 grammes, mixed with butter in the form of pills. The *Taenia* are ejected in a few hours afterwards—rarely longer than eighteen hours; but if no effect is produced in
about two hours, the action of the drug may be expedited by a dose of castor oil. Areca-nut has the inconvenience of being often vomited by the dog.

"Delematte has constantly obtained expulsion of tapeworms by the employment of sulphuret of calcium, in doses of 1 to 5 grammes for young dogs, 3 to 5 for adults. A purge of castor-oil is given an hour afterwards.

"I am not aware that calomel is much resorted to as a taeniafuge in England. Powdered areca-nut is perhaps the most employed, in doses of 15 grains to 2 drachms—about 2 grains for every pound of the dog's weight—mixed in soup, mucilage, the ordinary food, or, best of all, milk. Previous to the administration, the bowels should be emptied by giving a simple laxative, and then the animal should be kept without food for several hours. Sometimes the areca-nut powder is combined with 10 to 15 minims of male shield-fern extract, and this is said to be the most effectual remedy for tapeworms in dogs. If the parasites are not removed a second dose of the mixture is advisable several days later, when, should the result be still unsatisfactory, the animal strong, and the bowels not much relaxed, a moderate dose of castor oil and turpentine will sometimes bring away worms that were previously immovable.

—(Dun)."

SUB-FAMILY—ANOPLOCEPHALINEAE.—The tapeworms which compose this group have the body lancealote at the head, which is without proboscis and hooks; the segments in general are broader than long, and finally the eggs are provided with a delicate yolk membrane and a chorion enclosing the embryo. It is always prolonged into two horns, the so-called pyriform apparatus. The development is entirely unknown. Worms of this group live in adult condition in the small intestine of the herbivorous mammals. It forms hence a most important group for the stock-raiser.

These tapeworms have been the subject of extended study by Dr. Stiles, of Department of Agriculture, whose results are embodied in a bulletin of the department, from which the following data are selected. Stiles calls attention to the uselessness of descriptions based on external form alone, since it was due to this tendency that at least three distinct species were classed under one name. When one considers that every separate species forms a separate source of infection, it is evidently important to be able to distinguish readily the different species. Segments stained and mounted are the only safe guide to determine the species, and those segments with well developed ovaries and testes are best for this purpose.

Stiles gives the following key for the determination of the adult Cestodes of cattle and sheep:

1. Uterus, double; genital pores, double; eggs, with well developed pyriform apparatus.........................................................Moniezia R. Bl., 2.
   Uterus, single; transverse, with ascon-spore-like egg sacs; genital pores, double or irregularly alternate; horns of the pyriform apparatus not developed.............................................................Thysanosoma Dies., 10.
   Uterus, single or double and without ascon-spore-like egg sacs; genital pores irregularly alternate; eggs with a single shell; strobila narrow; testicles absent from median portion of median field.
   Stilesia Rail, 11.
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Doubtful species.................................................9, 12.

   Interproglottidal glands absent........................................3.
   Interproglottidal glands present........................................4.

   Genital pore in anterior half of lateral margin......................*M. alba.*
   Genital pore in posterior half of lateral margin....................*M. denticulata.*

4. Interproglottidal glands linear, not grouped around blind sacs........5.
   Interproglottidal glands grouped around blind sacs....................7.

   Interproglottidal glands very prominent and long (broad in reference to segment); head not very distinctly lobed; opening of suckers slightly elongated; segments attain 20-26 mm. in breadth......................*M. planissima.*
   Interproglottidal glands short and not prominent......................6.

6. Head very distinctly lobed and sharply separated from neck; opening of sucker round; neck as broad as head; segments attain 10-12 mm. in breadth..................................................*M. Benedeni.*
   Lobing of head less distinct; head not so sharply separated from neck; neck filiform; segments attain 8 mm. in breadth; thinner than foregoing species.............................................*M. Neumann.*

   Testicles generally in form of two triangles; space frequently left between the uteri in the median line; head pyriform, almost square when viewed in face; segments attain 6 mm. in breadth; end segments occasionally as long as broad...........................................*M. trigonophora.*
   Testicles generally in form of a quadrangle; no space between the fully developed uteri; end segments never as long as broad.........................8.

8. Head oblong when viewed *en face*; not lobed; suckers not distinctly raised; entire strobila thin; segments attain 9 mm. in breadth; end segments narrower...........................................*M. oblongiceps.*
   Head more or less distinctly lobed; nearly square when viewed *en face*; sucker raised; openings decidedly elongated; strobila often quite thick; posterior portion frequently orange color; segments attain 16 mm.—perhaps more—in breadth; end segments show a tendency to break off 1–3 at a time..................................................*M. expansa.*

9. Neck absent; head large, decidedly lobed; openings of sucker round; segments attain 8 mm. in breadth; doubtful species.......................*M. nullicollis.*

10. *Thysanosoma.—*
    Head very large (1.5 mm.); square, lobed testicles in median field; posterior flap of segments fimbriate; genital pores double. *Th. actinioides.*
    Head small; testicles in lateral fields; posterior flap not fimbriated; genital pores irregularly alternate (rarely double). ..........*Th. Giardi.*

11. *Stilesia.—*
    Median portion of median field occupied by a transverse uterus; “head 2 mm. in diameter.”.................................................*S. centripunctata.*
    Median portion of median field transparent; two lateral uteri in each segment; “head less than 1 mm. in diameter.”...........*S. globipunctata.*
12. Doubtful { Segments 2 mm. broad by 5 mm. long............. *Tænia Vogti. Species. } End segments 8 mm. broad........................... *T. cruegiera.

The genus *Moniezia* is characterized by the two full sets of genital organs with two uteri and two lateral pores in each segment; genital canals cross the longitudinal canals and the nerves dorsally; eggs with well-developed pyriform body. The genus is divided into three groups (a) *Planissima* group, characterized by the linear—not grouped—arrangement of the interproglottidal glands; (b) *Expansa* group, characterized by the interproglottidal glands grouped around blind sacks; (c) *Denticulata* group, comprising forms in which interproglottidal glands are absent.

As types of this genus, we shall consider the species representing the first group.

**The Flat Moniezia** *M. planissima* S. and H. 1893.

**Syn.**—*Tænia expansa*, in part, of all authors.

Total length 1 to 2 m., yellowish; head quadrate, 0.4 to 0.9 mm. broad, four suckers 0.25 mm. in diameter; segments at first extremely short; always much broader than long, and longer than thick; ripe segment 11 to 26 mm. broad by 1 to 1.75 mm. long; interproglottidal glands linear, large and very distinct; genital pores double, situated in the anterior portion of the lateral margin; vagina and cirrus in the same transverse plane; on the right vagina ventral, cirrus dorsal; on the left vagina dorsal, cirrus ventral; testes confluent in the middle line; uterine folds enter the lateral fields; eggs 0.063 mm. in diameter; bulb of the pyriform apparatus 0.020 mm., horns 0.042 mm., embryo 0.016 to 0.018 mm., hooks 0.009 mm. in diameter.

**Structure.**—The worm is remarkably flat and broad (Fig. 31); and yellowish when fresh; when preserved it becomes whitish. The segments increase in breadth very rapidly; they are very regular and the posterion flap of the seg-
ment overlapping the next following one is extremely distinct. When viewed from the apex the head (Fig. 32) is nearly square; the suckers are at the four corners and turned slightly forward, and the cavity of the sucker is round though the opening is oblong; its muscular walls are thick. The neck in some specimens appears short and thick, in others, however, very long and thin; in the examination of material much confidence cannot be laid upon the size of the head, and flattened specimens sure to be more or less artificial. The head of fresh specimens generally measure 0.7 to 0.9 mm. in diameter.

The segments are first very short and indistinct, but they soon become broader, longer, and sharper in outline; 7 to 12 mm. from the head, i.e., 150 segments, the segments measured 0.062 to 0.112 mm. long by 1.5 to 2 mm. broad; segments 70 mm. from the head measured 4 mm. broad by 0.3 to 0.55 mm. long. The posterior border of every segment is slightly wavy and overlaps the anterior border of the next following segment. Segments 14 cm. from the head measure 8 mm. broad and 0.4 mm. long; the genital pore is distinct and male and female canals are easily seen, the uteri alone are not visible. The arrangement of the various organs, however, can be best seen in segments 180 to 400 mm. from the head, which measure 9 to 13.5 mm. in breadth by 0.67 to 0.96 mm. long. These segments are quadrate in form.

The first thing which strikes the eye in the stained specimen is near the
joining of the segments the deeply colored line which runs parallel to the posterior edge of the segment in which it lies; on examining this in sections it is found to consist of elongated cells and constitutes the so-called interproglottidial glands (ig, Fig. 35) the linear arrangement of which is characteristic of this group of the genus Moniezia.

The arrangement of the sexual organs will be clear from an examination of figures 33 and 34. The male organs consist of the numerous small testes scattered through the entire central portion of the segment. The vas deferens, or male canal, crosses the ovary in a number of coils and communicates with the cirrus pouch in which the cirrus lies inverted; the male genital opening always lies dorsal to the vagina on the right, and ventral on the left.

From the female pore the vagina turns directly inward to an enlargement of the receptacle; (rs, Fig. 34) this is continued by a small canal (od) which crosses in the center of the complex of organs a small spherical gland, the shell gland (sg); the large fan-shaped gland in front of this is the ovary, the smaller one behind it is the yolk gland (vg). The uterus makes its appearance in older segments and the uteri of the two sides arise separately; as they increase in size by the accumulation of eggs they make numerous folds which (Fig. 35) completely fill the center and sides of the segments, even crossing the longitudinal canal dorsally. In the center the two uteri come together so that it is impossible to distinguish them; but before this stage is reached the other genital organs atrophy and disappear; the measurements of the eggs have already been given, and the character of these structures will be clear from an examination of the figure.

This worm is a common parasite in the small intestines of both sheep and cattle. It is found in France as well as the United States, where it seems to be generally distributed. The life history of the tapeworm is entirely unknown; all attempts to infect lambs by feeding them the segments directly have entirely failed, as might be expected since the analogy of the development of other tapeworms forces us to assume that the embryos pass first into an intermediate host, in which the larval stage is developed, before they are ready to develop in the intestine of the sheep.

Pathology.—The tapeworm disease may be positively diagnosed by finding the segments voided from the sheep with the dung. These will not, however, appear at an early stage.

The first indications of the disease given by the animals are uncertain, and usually escape notice as the small size of the young tapeworm produces but little disturbance in the intestines. As the tapeworms increase in size they fill the intestine and give rise to digestive and nervous disturbances; the
lambs become poor and thinner, they grow weaker, and the mucous surfaces
are pale and the fleece dry and harsh; they exhibit also a tendency to take
food and drink very frequently. In severer cases diarrhoea becomes pronounced, and they die from sheer exhaustion. The disease is very destructive to lambs and yearlings, and is most prevalent in the summer season. If the young animals pass safely through a certain period they are apt to recover.

TREATMENT.—Since the life history of the parasite is entirely unknown, the only preventive treatment which can be suggested is the observance of those sanitary rules which have already been emphasized.

Medical treatment is of some value in case the disease is recognized in its earlier stages. It is, however, not to be recommended in the case of animals already reduced to a low condition of health. Numerous receipts for the compounding of substances which will remove the tapeworm may be found in veterinary publications. The author hardly feels competent to decide between them. Of course the confining of the infected animals and the removal and destruction of the segments voided from the sick sheep are necessary to prevent re-infection of the flock.

Here as elsewhere too great weight cannot be laid on the necessity of preventive methods, since the animals, even if cured, remain long in a very poor condition of health.

No other member of the Planissima group has yet been found in America. As a type of the Expansa group, I select

The Broad Moniezia, Moniezia expansa. (R. 1810) R. Bl. 1891.

SYN.—Taenia ovina Goeze 1782; Halysis ovina Zeder 1803; T. denticulata Mayer; T. expansa in part of many authors.

This broad tapeworm (Fig. 36), which has heretofore been regularly confused with the preceding species, but is easily distinguished from it on anatomical grounds, has a very wide geographical distribution. It is found in England, France, Austria, Italy, Brazil, and the United States, east and west. No doubt it will be met with in other localities also. Total length 4 to 5 mm.; anterior part white, posterior part yellow. Head (Fig. 37) 0.36 to 0.7 mm. in diameter, more or less square, slightly lobed; suckers distinctly raised; apertures directed diagonally
forward; segments always much broader than long; end segments 16 mm. wide, and quite thick; topography of nerve, canal and genital organs (Fig. 38) similar to *M. planissima*; interproglottidal glands localized around blind sacs which open between the segments; eggs 0.050 to 0.060 mm., bulb of the pyriform apparatus 0.020 mm. in diameter.

**Structure.**—The only feature of this worm that requires a special explanation is the character of the interproglottidal glands, which suffices to distinguish it from the preceding species; stained specimens of the segments show near the juncture of the proglottids from 10 to 40 small circular organs (Fig. 38). The examination of sections shows these to be gland cells grouped about small flask-shaped pits, which open between the segments but below the projecting edge of the forward segment. These organs can be very easily recognized and are enough to distinguish this group at a glance, since they are found in segments of nearly all ages.

Since the species has not heretofore been clearly distinguished from the foregoing, the only suggestions which can be made in the line of the pathological effect of this worm and on the treatment are the same as that already mentioned for *M. planissima*, to which the reader should refer.

**Moniezia trigonophora** S. & H. 1893.

**Syn.**—*Taenia expansa* in part various authors; *T. Benedeni* Neumann in part.

Total length 1.6 to 2 mm., cream to whitish in color. Head 0.624 to 0.704 mm. in diameter; suckers not distinctly raised, 0.256 mm. in diameter, slit form. Neck thread-shaped, 2 mm. long. Segments generally broader than long, though end segments are
seen which are square or even longer than broad; rarely over 6 mm. broad by 2 mm. long. Relation of canals and genital organs same as in *M. expansa* and *M. planissima*. Testes arranged in two triangles, generally absent from median part of segment. Genital pore never behind the middle of segment. Eggs 0.052 to 0.060 mm. in diameter; bulb of pyriform apparatus 0.020 to 0.014 mm., horns 0.012 to 0.015 mm. long.

This tapeworm is reported from France as well as from the eastern United States. It is found in the small intestine of sheep and has been the cause of tapeworm epizootics in Canada and also in Blairsville, Pa.

**STRUCTURE.**—The worm (Fig. 40), is of a cream color when fresh; the head (Fig. 39), is noticeably small. The largest segments are 67 mm. broad by 2 mm. long. The head passes imperceptibly into the neck, which often has a false segmentation. The real segments begin 2 mm. behind the head where the worm is 0.48 mm. broad. Segments 50 mm. from the head, measure 2 mm. wide by 0.13 mm. long. Fourteen interproglottidal glands can be seen in these. Segments 60 cm. from the head measure 6 mm. broad by 1 mm. long; in these there are thirty-five to thirty-seven interproglottidal glands in each and the genital organs, with the exception of the uteri, can all be distinguished (Fig. 41). The posterior flap of each segment overlaps the next segment slightly. The testes are arranged roughly in two triangles (see Fig. 41), and the female organs in a rosette. The location of the organs is much the same as in *M. planissima*, but the female opening is not directly in the same plane as the male, it is slightly posterior to the latter. The interproglottidal glands are like those of *M. expansa*. In segments 100 to 150 cm. from the head a decided change in the appearance is caused by the development of the uteri, one on each side; the other sexual organs atrophy as these increase, and their folds occupy the entire lateral portion of the segments, leaving, however, a clear space in the center.

For pathology and treatment, see *M. planissima*.

Of the third, or *Denticulata* group, which is characterized by absence of the interproglottidal glands, no species has yet been found in this country. It seems unnecessary to consider these forms in detail here. Some facts
with reference to them, as well as the means for identifying the various species, are given in the key on page 280.

The second common genus of sheep and cattle tape-worms is *Thysanosoma*. It is characterized by double or single genital pores, and by a single uterus in each segment. The genital canals pass between the dorsal and ventral longitudinal canals and dorsal to the nerves. The pyriform body is not well developed.

**The Fringed Tape-worm**

*Thysanosoma actinoides* Dies. 1834. (Fig. 42.)

Syn.—*Taenia fimbriata* Dies. 1850; *Moniezia fimbriata* (D.) Moniez 1891.

Total length 1.5 to 3 m. Head large, nearly square, in front 1 to 1.5 mm. broad. Suckers very large, openings elongate oval, directed somewhat forward. Neck exceedingly flat and broad; segments begin almost immediately behind the head, the broadest measure 5 to 8 mm. wide by 0.4 to 0.6 mm. long, and are about two cm. from the posterior end. The posterior flap of each segment is broken up into fringed processes, which in the last segments are as long as the segments themselves. There are found in each segment two lateral genital pores, two ovaries, and two yolk glands, but only one uterus, which is situated in the anterior portion of the middle of the segment, and is composed of a small canal with numerous blind sacs.

**Structure.**—The head (Fig. 43) is very prominent and looks almost like a "T" on the anterior end of the worm; the four suckers are powerful and project prominently. Close to the head the segments are distinct and soon show on their posterior edges
the short prolongations, forming a sort of fringe (Fig. 44), which increases gradually in length as the segments grow older, and is so characteristic of this species. No interpilgottidal glands are present. Further description of the organs, so far as necessary for our purposes, may be found in the general characteristics.

This tapeworm is parasitic in the small intestine and gall ducts of the sheep. They are present frequently in very considerable numbers, 30 to 100 in a single animal not being rare. The worms make their way into the gall ducts when they are young and distend them as they grow larger. This species has been reported from South America, and is the most common parasite of sheep in all the western states, being reported from Utah, Colorado, Nebraska, Oregon, New Mexico, etc.

Pathology.—The parasite exercises a serious influence on the health of its host. It is present in nearly every sheep of a flock, and grows so slowly that the symptoms are not perceived until the tapeworms have attained considerable size. First indications of the disease are seen in the fall, and continue through the winter. Those which are not killed are so dwarfed and reduced in flesh that they are valuable neither for market nor as wool producers. The disturbances are produced at first by local irritation of the worms attaching themselves to the intestinal walls. And the increase of this irritation gives rise to chronic catarrhal inflammation of the intestines. Similar disturbances, though worse, arise from their presence in the gall ducts. Reflex disturbances are also the cause of varied symptoms. It seems probable that the "loco" of the western sheep has for its exciting cause this or a similar form. Not only do the sheep die from the disease, but the winter storms also tell more severely upon them, and other diseases carry off those which in stronger condition of health would not be seriously affected. Furthermore Curtis says that the "impoverished condition traceable to the parasite is a small
loss for each animal, perhaps, but for flocks of over five thousand sheep is thousands of dollars for each ranchman. Mr. Givens states his loss from dead sheep alone, for the preceding year, at from $3,000 to $4,000.”

The necessity of accurate investigation into the life history of this parasite cannot be too strongly emphasized. A disease which is the cause of more loss on the western plains than any other one should be thoroughly understood, and, furthermore, its prevention rather than its cure should be sought. The former however, depends directly on its life history, which is as yet unknown.

The various worm remedies for removing the tapeworms have been tried with but little success. No doubt this is largely due to the presence of a large number of the animals in the gall ducts, where they are beyond the reach of intestinal remedies.

To this same sub-family of the Anoplocephalinae belongs a genus which is characteristic both in appearance and in its host, Anoplocephala. The body is formed of segments in general very short and thick, and folded over each other slightly. The genital pores are unilateral, the uterus transverse, and the eggs provided with a pyriform apparatus. All are parasitic in the horse. Railliet gives this table for the determination of the three common species.

Head very large. [No posterior lobes] Anoplocephala plicata (Zeder) R. Bl. 1891.

Anoplocephala plicata (Zeder) R. Bl. 1891.

*Syn.*—*Tænia equina* Pallas 1781 in part; *T. magna* Abildg. 1789; *Alysellminthus plicatus* Zeder 1800.

Total length 9 to 80 cm. Head (Fig. 45) very thick, short and wide, slightly groved on each surface of the worm, 4 to 6 mm. in diameter. Suckers cup-shaped, directed forward. No neck. Segments increasing rapidly to the middle of the worm or to the end of the chain; maximum width of segments 5 to 20 mm., length of same 1 to 1.5 mm. Eggs 0.05 to 0.06 mm.,
pyriform apparatus 0.016 to 0.018 mm. long.

This, the rarest of the horse tapeworms, has been found in France, Germany, Russia, and Tunis. There exist several varieties of the species which are insufficiently described. Ordinarily the presence of tapeworms in the horse is unnoticed, but at times they give rise to intestinal disturbances or anaemia. The seat of this species is ordinarily the small intestine, rarely the stomach.

**Anoplocephala perfoliata** (Goethe) E. Bl. 1848.

*Syn.*—*Taenia equina* Pallas; 1781, in part; *T. perfoliata* Goethe 1782, nec Duj. 1845.

Total length 8 to 25 mm. rarely 80 mm. Head (Fig. 46) large, short and prolonged behind in four rounded lobes; suckers cup-shaped, directed forward. No neck. Segments thick, very short, increasing in size up to the middle of the body where they measure 15 mm. in width, diminishing gradually to the posterior extremity. Each segment overlaps the succeeding one to which it adheres only by the central portion. The last segments are often sterile. Eggs 0.065 by 0.08 mm.

This species is found in the cæcum, the ileum, and rarely in the colon of the horse. It is usually present in considerable numbers, twenty-five or more, and there may be even 300 to 400; in one instance a large basketful is said to have been removed from a horse that was killed because of anaemia after paralysis. Many authors unite in attributing pathological disturbances, often of a severe character, to this species.

**Anoplocephala mamillana** (Mehlis) R. Bl. 1891.

*Syn.*—*Taenia mamillana* Mehlis 1831; *T. perfoliata* Duj. 1845, in part.

Total length 1 to 5 cm. Head (Fig. 47) small 0.5 by 0.8 mm. four sided, often re-
FIG. 48.—Dipylidium caninum, small specimen, natural size. [After Railliet.]

Dipylidium caninum (L.) Leuckart 1863.

SYN.—Taenia canina L. 1767, nec Batsch 1786; T. moniliformis Pallas 1781; T. cucumerina Bloch 1782; T. elliptica Batsch 1786.

Total length 100 to 250 mm., and, in the last proglottis, a width of 1.5 to 2 mm. Head with bulbous rostellarum, which can be retracted. Hooks in four regular rows, containing a total of sixty. The neck is short and half their width of the head. First segments insignificant in breadth and length, rapidly becoming longer. With increase in size the segments become more sharply marked off and by constriction at the places of joining become, instead of trapezoidal, rather the shape of melon seeds (Fig. 48). The ripe proglottids have a light rose color, and separate easily from each other. Eggs in capsules of two to three dozen each; isolated eggs measure 0.043 to 0.05 mm., the embryo 0.032 to 0.036 mm. in diameter.

This species is the commonest parasite of pet cats and dogs. It is found in the posterior half of the small intestine. The specimens obtained from the dog are larger than those from the cat, and both have been listed as special varieties. Its occurrence in infants and young children is also recorded. The larval form, Cryptocystis

TRACTED INTO THE BEGINNING OF THE CHAIN. SUCKERs LATERAL, ELONGATED, OPENING BY A LONGITUDINAL SLIT. SEGMENTS THIRTY TO FIFTY IN NUMBER, BECOMING RAPIDLY WIDER THAN THE HEAD, AND ATTAINING SOON THEIR MAXIMUM WIDTH WHICH IS PREsERVED UP TO THE POSTERIOR END; THEIR LENGTH, HOWEVER, INCREASES TO THE END WHEN IT MAY EXCEED HALF THE WIDTH. EGGS 0.088 BY 0.050 TO 0.066 MM.

It inhabits the small intestine, and, particularly the further portions of it. Like the last species it is found in numerous examples at once, never, however, in such masses, the maximum recorded number being seventy-two. The living worm is very transparent and easily escapes observation. Railliet records that at Alfort, Paris, France, it is the most common of the horse tapeworms.

SUB-FAMILY OF THE CYSTOIDOTAENAE.—Body of moderate or small size. Head always round, with a single or double or multiple rows of small variable hooks. Genital pores variable. Larva a cysticeroid, i.e., a bladder worm of small size with poorly developed vesicle, or a pseudo-cystic, i.e., a larval form with no caudal vesicle. These tapeworms live in the adult condition in mammals and birds; the larvae are parasites of insects and mollusks.

The Genus Dipylidium includes tapeworms of small size with the segments provided with two genital pores, one on the right and one on the left margin, and corresponding double sets of sexual organs within the segments. Eggs with transparent membrane, and collected in distinct capsules. The larva is a Cryptocystis and lives in the body cavity of certain insects.
Trichodectis Villot, lives in the visceral cavity of Trichodectis canis, the dog louse, and of Pulex cerraticeps P. Gerv., the dog flea.

The structure of the proglottid is sufficiently illustrated in Fig. 49, so that further explanation is unnecessary.

Life History.—The developed egg is spherical and possesses transparent membranes through which the six-hooked embryo may be seen in the interior. By rubbing the substance of the crushed segments of the tapeworm on the skin where the lice are abundant it is possible to infect them and in the body cavity of the louse to find the Im'va of the tapeworm. This larva is known as Cryptocystis trichodectis and is a pear-shaped body (Fig. 50), about 0.3 mm. long. It shows the infolded head with suckers, and the rostellum with hooks at the bottom of the infolding. While this was first found in the body cavity of the dog louse, its more usual host is the dog flea. Both of these insects become infested by the larva while they are gnawing the matter attached to the hairs of the dog, among which are often remnants of the segments of the tapeworm.

It is a well known fact that the dog endeavors by gnawing to rid itself of the fleas and lice and in so doing will from time to time swallow the larva of the tapeworm. The development from the larva to the adult worm goes on very rapidly in the intestine of the dog; not more than four or five weeks are necessary for the production of ripe segments.

Pathology.—This tapeworm is found in from one-fifth to four-fifths of all the dogs examined by various European investigators. Here in Lincoln it is hardly less common.

It is also found in large numbers in each dog, as one would infer from the life history and probability of infection. As many as 2,000 are recorded from a single (Cryptocystis trichodectis) of Dipylidium caninum, x60. [After Leuck-
Tamia on pages 278-9. On page 277, the student will find a table for the identification of the various species of tape-worm found in the dog.

The genus *Hymenolepis* includes tapeworms with a small, often slender body; the head is either armed or unarmed, and the segments are wider than long, and the lower corners project like saw-teeth. The genital pores are located on the left margin, while the anterior or ventral surface contains the female genital organs. The egg possesses three coverings.

These tapeworms are parasitic in man, bats, rats, mice, and even insect eating birds. Only one species deserves mention here.

**Hymenolepis nana** [v. Sieb.] (Fig. 51.)

Syn.—*Taenia nana* v. Sieb. 1852, nec v. Ben. 1861; *T. egypitca* Bilh. 1852, nec Krabbe 1869; *Diplacanthus nanus* Weinl. 1858.

Total length 10 to 20 mm., breadth 0.5 to 0.7 mm. Head spherical, 0.3 mm. in diameter, with four round suckers and a rostellum bearing a single row of 24 to 28 very small hooks. Number of segments 150 to 170, of which 20 to 30 are ripe; the largest are 0.92 by 0.30 mm. Embryos 0.023 mm. in diameter with three membranes. Eggs 0.04 mm. in diameter.

The structure of a closely allied species is shown in Fig. 52.

The *H. nana* is found in the small intestine of man. It is so closely allied to *H. murina* of rats and mice that some investigators have maintained the identity of the two forms. It has been discovered in Egypt, Italy, England, Servia, Argentine Republic, and the United States. The worms are usually present in considerable numbers. In such cases they excite digestive troubles of some severity. Deterioration of general health and often reflex nervous disturbances are induced in many cases. A full history of such instances has been collected by Blanchard and published in the Bibliothèque Générale de Médecine. The disturbances are more serious than those caused by larger tape-worms. Diagnosis can be made from the presence of eggs in the faeces, and treatment should be in the hands of a physician.

**Family of the Bothriocephalidae.**

The head is oval and flattened; it carries two elongated suckers corresponding to the flat sides of the body. The uterus opens on the middle of the ventral surface near the
front of each segment and the eggs are continually discharged. The genital organs persist. The embryo possesses ordinarily a covering of fine vibratile hairs or cilia by which it makes its way about in the water.

Of the large number of species in the family the greater part are fish parasites. Only one which is a human entozoon need be considered here.

**Bothriocephalus latus** Bremser 1819.

**Syn.**—*Taenia prima* Plate 1603; *T. vulgaris* and *T. lata* L. 1748; *Dibothrium latum* Diesing 1850.

Total length 2 to 9 m., occasionally up to 20 m. Head oval, with rounded or pointed tip, flattened and bearing on its edges the two groove-like suckers. Its length is 2.5 mm and its breadth 1 mm. Neck very variable. Body thin and flat, especially towards the edges. Number of segments 3,000 to 3,500. The ripe segments measure 3 to 4.5 mm. in length by 10 to 12 mm. in width. Towards the end of the chain the width decreases and length increases until the form is quadratic or even elongated. Genital orifices on the median ventral line, that of the cirrus and of the vagina being on a small papilla near the anterior edge of the segment, while the opening of the uterus is a short distance behind. The accumulated eggs in the uterus of ripe segments gives rise to a star-shaped marking, some like a "*fleur de lis."*

The proglottids are not freed singly, but in considerable numbers. Eggs oval, 0.05 to 0.07 long, 0.035 to 0.045 wide; they have a brown shell with a cover.

This parasite is found in the small intestine of man, dog, and perhaps the cat. The larva is found in the muscles and viscera of numbers of fish, pike, burbot, grayling and various trout. The distribution of the adult is naturally confined to regions in which these fish are abundant, and yet it is not found everywhere that the fish are known. The region about lakes Geneva, Neuchatel, and Bienne in Switzerland, the lake region of upper Italy and the shores of the Baltic are the European regions in which the parasite is commonly met with; elsewhere it is rare. In Asia it is certainly very common, especially in Japan where the larval host is a salmonid, eaten raw by the natives. I do not know that it has ever been reported from the United States.
STRUCTURE.—In some respects the structure of this tapeworm differs widely from that of those already considered. The form of the body (Fig. 53) agrees in general save that the segments are not of equal thickness throughout, but much thicker in the median field than near the edges. Of the size of the various proglottids enough has already been said in the general description.

The arrangement of the sexual organs requires more detailed consideration. This system is represented in Figure 54. The male organs, consisting of the numerous small testes (tt) in the two lateral areas and the vas deferens (sp), are not unlike the male organs of the *Taenia* (Fig. 9) save that the male orifice (op), is at the middle of the ventral surface here instead of at the lateral margin as there. The yolk glands (vt) are scattered over the entire lateral fields in the surface layer (as on the left of figure 54); the ovary (vo) lies in two lateral masses at the posterior edge of the segment and between them the shell gland covers the beginning of the uterus. In the figure ovaries and shell gland are represented as a solid mass (vo). The uterus makes but 4 or 5 loops at each side and opens (at om) behind the male orifice. The second opening (ovg) near the orifice of the vas deferens is the opening of the vagina, a tube leading back through the segment to the shell gland and beginning of the uterus; it is the tube by which the sperm enters. Since the uterus has an external opening the eggs may be discharged by this means.

LIFE HISTORY.—The embryo, which is not developed until some time after the eggs reach the exterior, has an external layer of cells with long vibratile hairs, or cilia (Fig. 55, A) and an internal mass of cells, in which are three pairs of hooks. Its further development is a matter of doubt. The external layer of cells is thrown off when it enters the larval host, and the six-hooked embryo
may make its way directly into the viscera, or muscles where it is found, but attempts to infest various forms have failed, so that some observers hold to the necessity of a preliminary stay in some small aquatic animal.

Braun found the larvae (Fig. 55, B) plentiful in various fish sold in the market at Dorpat, and since then they have been discovered in other places also. They are easily killed by a solution of salt and by a temperature of 130° F., so that from well cooked fish there is no danger of infection.

The effect of this species does not seem to be much different from that of the other large human tapeworms. It is said to be easily removed.

In reference to the diagnosis it may be said that the peculiarity of the shape and the evacuation of the segments, not singly, but in short bands, afford easy distinctions. Prevention depends simply on the thorough cooking of all fish.

**Order III.—NEMATODES.**

The Round or Thread Worms constitute a large and very variable group. They are characterized by a cylindrical, sometimes threadshaped body, by the
absence of segments, and by the presence of a body cavity. All of them possess an alimentary canal at some time in their life history. It is a permanent structure in the members belonging to the sub-order of the true Round Worms or Eunematodes, but in the sub-order, of the Hair Worms, or Gordiacea, the alimentary canal is much reduced in the adult, the mouth is closed and a solid string of tissue marks the oesophagus; at the posterior end, however, the canal retains its cavity and affords a common outlet for the sexual organs, both male and female. In the Eunematodes, on the other hand, the male organs empty in common with the alimentary canal, but the female sexual pore is variable in position and always independent of any connection with the digestive tube.

By far the largest number of forms, and those most important for our purposes, are included in the first sub-order, or Eunematodes. The great majority of them are parasitic forms, but there are not wanting a few small species which live free in damp places in the earth or in water. The free forms are uniformly insignificant, but the parasitic species include both extremes of size. There are blood parasites of microscopic dimensions and the other extreme is represented by skin parasites of more than a meter in length. In respect to location in the body of the host, no group of parasites presents wider variations.

In general form they are cylindrical, usually much elongated, and never show any division into segments. The external surface of the body is covered by a transparent tough membrane of a horny substance, which is called chitin. This frequently shows on the outside delicate rings or fur-
Among the most important organs are the lateral “lines” as they are called. These appear as two delicate stripes (c, Fig. 56) running the length of the body along the sides and are usually distinctly seen. Two others, the median lines, extend along the dorsal and ventral surfaces, but they are commonly much less distinct.

The muscular layer of the body lies almost directly below the external covering, and is easily identified as a longitudinal set of fibres. These longitudinal muscles are interrupted by the lines already mentioned and form hence four muscular areas. Directly within the muscle layer comes the body cavity, which contains the organs of digestion and reproduction. The alimentary canal is usually a straight tube extending from the mouth which is located at the anterior tip of the body to the anal opening lying at the posterior end, or not far from it, on the ventral surface. One can distinguish, however, at least three regions of the canal which are important for the determination of certain species. They are (1) the so-called pharynx or mouth cavity, an enlargement at the very beginning, then (2) a slender oesophagus, (e) which is not infrequently enlarged at its posterior end into one or two bulbs, and (3) the intestine (i) somewhat larger in diameter than the first two parts, but becoming narrow towards its termination. The sexual organs consist of a single or double tube, which is extremely long and lies coiled backward and forward, occupying early the entire space of the body cavity. The blind end of this tube is very fine; it increases in diameter, however, gradually, and has an enlargement near its termination at the sexual opening. The female sexual orifice lies more com-
monly near the middle of the body, and the single tube which passes inward (vg, Fig. 56. B; ν, 57, A,) divides almost immediately into two such tubes as those described. In the male the sexual organs empty with the alimentary canal. They consist of only a single tube such as that described above. The male is also supplied in most cases with one or two needle-like organs which project from the common opening of the alimentary canal and sexual organ; they are the "spicules," and are used as copulatory organs.

The Nemetodes are either oviparous or ovoviviparous, that is, the eggs are laid and develop outside of the body, or the eggs are retained in the female ducts within the body until they are hatched, in which case the young come forth alive. In the first case, the eggs are provided with a thick shell fitted to resist long drying and to protect the embryo under unfavorable circumstances; in the second case the shell is frequently very thin and insignificant.


Syn.—*A. megaloecephala* J. Cloquet 1824.

The male is 15 to 25 cm. long; the female 18 to 37 cm. The female genital opening is in the anterior fourth of the body; the male has two equal spicules and a large number of papillae in front of and behind the anus. Both sexes have surrounding the mouth three lips, one dorsal, and two ventral; the eggs are spherical, 0.09 to 0.1 mm. in diameter.

This is the largest of the ascarids and is found in the small intestines of the horse and the mule in considerable numbers, as many as a thousand to fifteen hundred specimens having been obtained from a single horse. Its geographical distribution seems to be very wide, and is that of the horse itself. In many cases it appears to have no effect on the health of its host, but in others it certainly causes intestinal catarrh, colic, and sometimes reflex nervous troubles, so that it is undoubtedly better to keep horses free from the parasites. The best vermifuge to be employed is arsenous acid in doses of one to two grammes a day. The treatment must be continued from two to three weeks.

*Ascaris lumbricoides* L. 1758.

Lips (Fig. 58) almost similar, approximately semi-circular with fine teeth on the edges, the upper possesses two papillae, and each of the lower ones only a single papilla. Male 15 to 17 cm. long and 3 cm. thick, with the posterior end curved towards the ventral face. It has two short spicules and a large number of papillae. The female is from 20 to 25 cm. long, and 5 mm. thick, with conical posterior end. The female sexual opening is in the anterior third of the body, and situated in a ring-shaped depression. Eggs elliptical, 0.050 to 0.075 mm. long by 0.040 to 0.058 mm. wide.
This is the common thread worm of children, and inhabits the small intestines of man; it is probably the same species as A. suum Goeze 1782 of the pig, and A. ovis of sheep. It seems to be distributed over the entire world, but it is more common in those regions and among those people who exercise little care with regard to drinking water. It is for this reason that it is so common among children, who are much less fastidious than grown people. Its structure requires no particular explanation.

Life History.—The development of the eggs does not begin until long after they have been expelled from the human intestine, and is dependent upon both moisture and warmth. Under favorable conditions the embryo is completed in from 30 to 40 days, and then lies in a spiral within a thin shell which it does not seem to leave so long as the egg remains free. The further development is believed by Leuckart to require the intervention of another host in which a larval stage is passed. Davaine was successful in hatching the embryos in the intestine of the rat and believes that the intervention of a second host is unnecessary. In the latter case the eggs are probably introduced into the human system with the embryo within by means of the drinking water. The embryo is then set at liberty in the alimentary canal, and further development is merely growth. Of course the infection may be brought about by the means of vegetables, especially salads, which have been imperfectly cleaned.

Pathology.—It has already been mentioned that the worms are most frequently found in children, but this is due to the ease of infection rather than to conditions for development, since the worm has been obtained from persons of all ages. Ordinarily one finds several specimens at once and in some cases from 500 to 1,000 have been obtained from a single individual. Their presence in the intestines give rise in many cases to severe nervous disorders, hysteria, epileptic attacks, etc., the reason for which have not been explained. Disturbances due to their entering the gall or pancreatic ducts or to penetrating into the body cavity are by no means rare, but differ in the individual case. The worms show no desire to leave the alimentary canal spontaneously, but must be removed by medical treatment. Diagnosis of their presence is easily made by examination of the feces, which show the characteristic brown eggs of the size already given.
Ascaris vitulorum Goeze 1782.

This species is closely related to the last. The body is a little more slender than the head smaller, and the lips (Fig. 59) differ in shape as will be seen by consulting the illustrations. The female genital opening is situated in the anterior sixth of the body; the eggs have a diameter of 0.075 to 0.080 mm.

The species is found in the small intestines of cattle, especially calves; it has been found in Europe and Asia; and Neumann states that it gives rise to intestinal inflammation which may be severe.

Ascaris mystax (Zeder) Rud. 1802.

SYN.—Lumbricus canis Werner 1782; A. cati and canicula Schrank 1788; A. tricuspidata and felis Bruguière 1791; A. Werneri Rud. 1793; Fusaria mystax Zeder 1800; A. marginata, and A. mystax Rud. 1802; A. alata Bellingham 1839.

Anterior end ordinarily curved and provided with two wing-like membranes which extend one along each side; lips almost equal, 3 to 6 cornered. Female genital opening situated in the anterior fourth of the body; male 90 mm. female 200 mm. long.

This Ascaris is at home in the small intestine of the dog, cat, wolf, lynx, lion, etc. It has also been reported from man. Varieties have been distinguished according to the size of the individuals, those from the cat are smaller, those from the dog slightly larger. The life-history and pathology are, so far as known, similar to what has been said for A. lumbricoides.

Oxyurus vermicularis (L.) Bremser 1819.

SYN.—Ascaris vermicularis L. 1767. Fusaria vermicularis Zeder 1803.

Cæophagus long and followed by a distinct bulb, with teeth; males small, with only one spicule; female, with long awl-shaped heads. Wing-like projections (Fig. 60) from the dorsal and ventral surfaces near the head are present, and also a low projection along the lateral lines of the body. Male, 3 to 5 mm. long, with spirally rolled tail. Female, 9 to 12 mm. long, tail awl-shaped. Female genital opening, situated a little in front of the anterior fourth of the body; eggs elliptical 0.050 long by 0.025 wide.

This well known parasite is found in the cæcum of the human intestine. It appears to be present everywhere; like the Ascaris, it is more frequent in the city, but unlike the latter, it is found in the colder latitudes abundantly.

LIFE HISTORY.—The first stages of its development are passed in the uterus of the worm, and when the egg is laid it already contains an embryo; a temperature of at least 30° C. and moisture, are
necessary for further development. It is not able to endure the continued action of clear water, however, and hence that agent must play a secondary role in its distribution. Leuckart has established the direct development of this worm, i.e., its development without an intermediate host, by his experiments. He and some of his students swallowed some dozens of eggs which had been incubated and enclosed already ripe embryos; these persons were found to be infected with the parasites 6 or 7 mm. long by the end of two weeks after the experiment.

Pathology.—This parasite is found in persons of all ages, at least one person in every five in northern Germany being infected. Frequently it seems that the parasites have no effect on the general health of the host, but in other cases, especially if very numerous, they give rise to serious complications.

The treatment of the malady, which is somewhat difficult, should always be in the hands of an experienced physician.

The Family of the Strongyles.—An elongated cylindrical body rarely so fine as to deserve the name of hair-like, a mouth provided with six papillae, sometimes in the axis of the body, sometimes turned towards the dorsal or ventral surface, and frequently armed by chitinous teeth are characteristics of this group; the oesophagus is more or less enlarged at the posterior end, but not provided with a distinct bulb; the males possess a caudal sac, which furnishes one of the chief elements in classifying this group; it is in shape like a saucer or, if deeper, a bell encircling the tip of the tail and including within itself the common opening of the alimentary canal and the sexual organs. The one or two spicules project from it, and the ribs which mark its surface have characteristic arrangements in different species; these have received the name, according to their position (Fig. 61), of posterior, posterior-external, middle, anterior-external, and anterior. The margin of this sac may always be notched or deeply cut so that it appears to consist of two separate parts; near the male orifice a small number of papillae are often found; the female has one or two ovaries; the female sexual opening is very variable in position. The eggs when laid have undergone at least part of the development. This family includes a considerable number of important parasites of which the following have some special claim to attention.

**Dioctophyme gigas** (Rud.) Coll. Meyn. 1802.

Syn.—*Ascaris canis et martis* Schrank 1788; *A. visceralis et renalis* Gmelin 1789; *Strongylus gigas* Rud. 1802; *Eustrongylus gigas* (Rud.) Diesing 1851; *Strongylus renalis* Moq. Tand. 1860; *Eu. visceralis* Raill. 1885.
Generally blood red, slightly tapering at both ends, especially the anterior, and with a triangular mouth bordered by six small papillae. The male 18 to 40 cm. long, 4 to 6 mm. broad. The caudal extremity obtuse and terminated by a membranous pouch without rib lines. One slender spicule present. The female 20 cm. to 1 m. long; 5 to 12 mm. broad; tail obtuse and slightly curved; the female sexual opening is situated near the mouth, the eggs are ovoid, brown, and measure 0.068 to 0.080 mm. by 0.040 to 0.043 mm.

This is the giant of all the Nematodes (Fig. 62), and is a kidney parasite encountered in man, dog, cattle, horse, wolf, and many fish-eating animals.

LIFE HISTORY.—The development begins in the female worm, but is completed only after the egg has been expelled from the host. Five or six months in winter and shorter time in summer are necessary for the remainder of the development of the embryo. It lives a long time in water, but cannot endure drying. It has been found that the embryos will not develop if transferred directly to the dog or some other host of the adult animal, so that it seems probable that an intermediate host is necessary. This has been conjectured to be a fish, but no evidence has been obtained.

PATHOLOGY.—Observations are at hand on the effect of this parasite in the dog. In some instances the presence of the worm does not cause any pain; in most, however, it exercises a serious influence upon the health of the host. This is shown by loss of flesh, and by every manifestation of pain on the part of the animal. The parasite causes, of course, distension of the organ or part in which it is found and a corresponding effect on the function of the same. The tissue of the kidney is gradually destroyed until the coating of the organ constitutes no more than a bladder in which the worm lies. It may escape by the ureter or may make its way into the body cavity through the wall of the kidney, in which case it usually penetrates the wall of the abdomen, causing the appearance of an ulcer or tumor. No cases have been found in which more than one kidney is affected.

The diagnosis of the parasite is difficult. Suspicion might be excited by bloody urine, but the diagnosis could only be made by microscopical examination demonstrating the presence of ova of the characteristic size and shape. Cure would be difficult, though by means of a proper remedy the worm might be made to leave the body.
Strongylus filaria Rud. 1809.

A whitish worm, long thread-like, somewhat pointed at both ends, the head more obtuse and without projections; male 3 to 8 cm. long; caudal pouch elongated, posterior ribs three-parted, middle ribs simple, anterior ribs two-parted; spicules brown, short, thick. Female 5 to 10 cm. in length; tail straight and conical; female sexual pores in the third fifth of the body; eggs elliptical, 0.112 to 0.135 mm., by 0.052 to 0.067 mm., enclosing, when laid, an embryo which instantly breaks from the shell; the embryos 0.54 by 0.02 mm., pointed at the posterior end and with a slight enlargement at the head.

This Strongylus is found in the respiratory passages (bronchi) of sheep, goat, and some other forms. It occurs in both Europe and America.

Life History.—The embryos of this parasite are expelled from the air passages of the host in coughing. They do not live long in water, and Leuckart was unable to infect a lamb by the embryos directly, so that there is probably an unknown stage in the life history.

Pathology.—This thread lung-worm, as it is sometimes called, is the best known of the sheep lung-worms. Together with its eggs and embryos it causes a catarrhal inflammation which is known as verminous bronchitis, husk, hoose, or paper skin. The disease attacks young animals, and those under two years suffer most, as in many other cases. The first symptoms are slight, but soon become aggravated; hard breathing, coughing, and general weakness are the most evident symptoms. A positive diagnosis is made by showing the presence in the matter coughed up of the eggs and worms.

The sheep lose flesh by the disease, and in the last stages the symptoms become very severe; owing to a lack of sufficient respiration the skin becomes dry and hard, resembling parchment, and hence the name “paper-skin.” The animal is carried off in the course of three or four months by exhaustion or suffocation. In cases where the symptoms are severe the patients rarely survive. The height of the disease comes in fall, and those which survive its attacks recover in the spring. They are, however, much reduced in flesh, and the growth of the fleece is retarded. A very large per cent of those attacked succumb.

Treatment.—It is of course true that the best nourished animals are most fitted to withstand the attacks of the parasite, and after the animals become sick the diet must be especially cared for; at the same time infected pastures should be avoided. Medicinal treatment is of little avail unless resorted to at an early stage, and the difficulty of applying the treatment will render it impracticable for large flocks. Tracheal injections seem to be decidedly advantageous, but should not be resorted to by other than an experienced veterinarian. In conclusion, I quote some recommendations from Neumann (page 590) with reference to this disease:

“Two different procedures in treatment are pursued. In one, substances are passed into the digestive canal, which, being diffused in the blood, are believed to be capable of attacking the worms in the bronchial tubes. But experience
has shown that, while such treatment is troublesome to carry out, its efficacy cannot be relied upon.

"Success is more certain with fumigations, as they penetrate directly to the worms, stupify them, and induce fits of coughing that cause their expulsion. The fumigation should be practiced only in buildings from which all forage is previously removed and which are well closed. Into these the diseased animals are introduced, and on a red-hot shovel are placed rags, horns, feathers, hair, old pieces of leather, empyreumatic oil, tar, juniper berries, asafetida, etc. The intensity, duration, and number of these fumigations are graduated as the sheep become accustomed to them. At first once a day may suffice, and then the intensity should be moderate and the duration about ten minutes. Afterwards two, and finally three may be given during the day, each lasting for twenty minutes. Kowalswsky says he has obtained very good results from similar fumigations. Fumigations with chlorine, sulphur, and sulphuret of mercury or cinnabar have been recommended, but they are dangerous.

"Stephen recommends as follows: put about forty lambs at a time into an air-tight house and place tar, sulphur, and turpentine in a pot of burning coals, suspended by a chain from the ceiling, and brought as near to the heads of the animals as possible. The fumes are to be allowed to fill the house, and more ingredients are added as required, the lambs being kept in the place for twenty-five minutes each time, and the process to be repeated on three occasions.

"Tracheal injections in the verminous bronchitis of calves are of great utility, but for a flock of sheep they would be troublesome and difficult to administer. However Nieman, has successfully employed them on 384 sheep belonging to several small owners. He used a solution of two parts of iodine and ten parts of iodide of potassium, in 100 parts of distilled water. This fluid was mixed in equal parts with oil of turpentine, and made into an emulsion with olive oil. Each sheep received 5 to 8 grammes of the mixture, and the number of injections varied according to the gravity of the disease—from 2 to 3 at two days' interval. The worms were killed and expelled during the paroxysms of coughing, and the bronchitis was modified.

"The medical treatment should be assisted by very nourishing food, and by bitter, stimulating, and ferruginous tonics, which arouse the digestive functions and allow those animals which are least exhausted to reach the period of elimination of the parasites."

**Strongylus rufescens** Leuckart 1865 (Fig. 63).

**Syn.—**Str. minutissimus Megn. 1878; Pseudalius ovis-pulmonalis A. Koch 1883; Str. ovis-pulmonalis C. Curtice 1890.

Worm reddish brown, thread-like; mouth with three lips; male 18 to 28 mm. long; caudal pouch notched deeply behind, and slightly on the side; posterior ribs indistinct, middle rib double, anterior ones divided, spicules arched. Female 25 to 35 mm. long, tail blunt; female sexual pore at the base of a small eminence just in front of the anus; eggs elliptical, 0.075 to 0.120 by 0.045 to 0.082 mm.
Strongylus rufescens is found in the sheep and goat, where the worms may occur in the air passages or bronchi, but seem to penetrate also into the ultimate lung cells.

Pathology.—The disease which is caused by these parasites is known as verminous pneumonia. It may exist with parasitic bronchitis, which is caused by the last described species.

This disease manifests itself either as a globular, diffuse, or nodular pneumonia. The last is also known as pseudotuberculosis. It is caused by the accumulation of eggs and embryos in certain parts of the lungs, where they constitute distinct centers, apparently tuberculous, and this is the most frequent form of the disease. This disease is extremely common, and all that has been said with reference to the pathology and treatment of the disease caused by the last species applies with equal force here.

**Strongylus contortus** Rud. 1803.

Syn.—*Str. ovinus* O. Fabr. 1784; *Str. ammonis* Rud. 1819; *Str. filicollis* Molin 1860, nec Rud. 1803.

Body red or pale, thread-like, tapering towards the extremities; two small lateral papillae some distance from the anterior end. Mouth unarmed; male 10 to 20 mm. long. Caudal sac (Fig. 64) composed of two elongated lobes each with four ribs of which the middle and anterior are doubled; the right lobe has also an accessory projection. Two spicules with an accessory piece. Female 20 to 30 mm. long, tail elongated very sharp, sexual opening towards the posterior fifth of the body, covered by a strong tongue-shaped flap. The parasite lives in

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![Diagram of Strongylus rufescens](image.png)

**Fig. 63.—Strongylus rufescens.** A, male and female, natural size. B, caudal end of female, x50. C, caudal end of male, x100. [After Railliet.]

![Diagram of Strongylus contortus](image.png)

**Fig. 64.—Caudal end of male of Strongylus contortus; x50.** [After Railliet.]
the fourth stomach of the sheep and goat, and is also reported from the cow where it is said to constitute a variety somewhat larger than the one described. The development is probably direct, and the embryos, according to Leuckart, develop well in muddy or stagnant water. The probable means of infection is then the drinking water of the cattle. In Germany this parasite has been considered as the cause of an epizooty which attacks especially lambs and yearlings. Similar cases are reported from England, and Stiles has observed an epizootic in Pennsylvania where the worms were extraordinarily numerous. The disease appears to be most common in places with sandy soil and more or less stagnant water. The symptoms somewhat resemble those of distomatosis. Anthelmintic remedies are recommended for removing the worms, and transferring the sheep to uninfected pastures is absolutely necessary to prevent the recurrence of the disease. Stagnant water should not be used for the animals.

**Oesophogostom columbianum** Curtice 1890.

The body is pale and the head curved so as to appear like a hook. The mouth circular and armed with a double crown of convergent teeth, the outer ones long and curved, the inner shorter and two pointed; two narrow lateral folds extend one-fourth the length, beginning at the neck fold. Males 12 to 15 mm. long; caudal sac three-lobed; posterior ribs divided; middle and anterior lobes, double; two spicules 0.7 mm. long. Female 14 to 18 mm. long; female sexual pore just in front of the anus on a papilla; eggs elliptical, 0.090 by 0.050 mm.

The worm lives in the large intestine of the sheep below the cæcum, and the embryo forms tumors in the intestinal walls of both small and large intestines. The species has been found thus far only east of the Mississippi river.

**Life History.**—The wanderings of the parasite from the time the eggs are discharged from the intestines to their discovery in the tumors are unknown; the youngest forms known are found encysted in the intestines and are little different from those in the eggs. The cysts incite inflammation in the tissue about them, and the worms come from the cysts to live in the inflamed substance. After several months, when a size of 3 to 4 mm. is obtained, they leave the tumor and begin the adult life in the intestine.

**Pathology.**—The tumors are found in the sub-mucous tissue, and at first each appears like a sac filled with fluid; later there accumulates a green, cheesy substance, which gradually increases in amount. From the largest tumors the worms have already escaped.

Diagnosis of the disease can only be made from post mortem examinations. It is probable that, except in extreme cases, no external disturbance can be noticed; then, however, general debility, and even diarrhoea, reduced the health of the flock considerably. Ordinarily, the adult worms are few in number compared to the tumors, and it is the latter alone which have caused much trouble. To the butchers these are known as "knotty" entrails, and are useless for making sausage cases, entailing thus quite a considerable loss to the sheep raiser.

**Treatment.**—No medicinal remedies can be suggested for the removal of the adult worm, and removing the embryos is evidently quite beyond power of
Sclerostoma pinguicola* Verrill 1870.

**Syn.—**Stephanurus dentatus Diesing 1839; St. Nattereri Cobbald 1879; Strongylus (Scl.) pinguicola (Verr.) Magalh. 1894.

Body elongated, cylindrical, mouth terminal, armed with six teeth, of which the two opposite are stronger; male 22 to 28 mm. long; caudal sac composed of five lobes united by a delicate membrane; spicule filiform. Female 33 to 40 mm. long; tail curved, but prolonged into a small point and provided on each side with a short process. Sexual opening at the middle of the body; eggs 0.084 mm. in length.

This parasite is found in the organs of the abdomen, especially in the fat tissue, of the hog. It has been called by some Americans the kidney worm since at times it penetrates into the kidneys. It appears to be very common in America, and is frequently found in lard, so that it has also received the name of lard worm. Some have even regarded it as cause of the hog cholera. The parasite was first found in New England by White, and Verrill has given an account of it in his paper on animal parasites. Dinwiddie reports that in Arkansas it is so common in the livers of hogs as to render them unfit for use. In those he examined were numerous small cavities filled with pus-like cores which marked the wanderings of the parasite. So far as is known, their only effect on the animals is to render the liver unfit for use. This represents, however, a considerable annual loss to hog raisers.

Sclerostoma equinum (O. F. M.) de Bl. 1828.

**Syn.—**Strongylus equinum O. F. M. 1784; St. asininus Viborg 1795; St. armatus Rud. 1803; Scl. armatum Dies. 1851.

Body brown or gray, straight and rigid, the anterior part broader, mouth circular, distended, with chitinus rings provided with small teeth; the mouth capsule is supported by a longitudinal rib, and has at the bottom two round, sharp plates. Male: length 18 to 20 mm., caudal sac (Fig. 65), 3-lobed; posterior ribs 3-parted, the middle, double, the anterior divided; two spicules long and slim. Female: 20 to 55 mm. long, with a long, blunt tail, and the sexual pore in the last third of the body; eggs elliptical, 0.092 by 0.050 mm.

This Sclerostoma, more generally called by veterinarians, the armed strongyle or the palisade worm, is found in the caecum, or rarely the colon of the horse. It is the commonest parasite of that animal, and is usually found in considerable number, more than 1,000 having been counted in a space of two inches. They are also frequently found in a larval condition in the aneurisms

*With regard to the name of this form Dr. Stiles writes: “Stephanurus dentatus is unquestionably a Sclerostoma. The earlier specific name dentatus, however, cannot be combined with the generic name Sclerostoma, as the term Sclerostoma dentatum de Bleinville 1829, already exists in synonymy. Verrill’s specific combination of 1870, Sclerostoma pinguicola is accordingly the earliest combination available.”*
of the mesenteric (Fig. 66), and arteries as well as in the cysts on the cæcum and duodenum. They are found in all parts of Europe, and have been reported from Canada and the United States.

**Life History.**—The eggs are expelled with the dung, and hatch in a few days in a damp place; under favorable conditions of moisture they continue to grow and moult, and Railliet has kept them a considerable time in this condition. Probably at this period they enter the body of the horse in the food or drinking water, and fix themselves in the mucous membrane; some remain in the cysts which are formed about them, the others reach the blood vessels, fix themselves in the large arteries of the abdomen and give rise to aneurismal dilatations in which is a rough clot adherent to the inner surface, and in this, the worms are developed. After a stay of uncertain length in the aneurism they leave it and are carried by the blood to the cæcum, where they form sub-mucous cysts. These they abandon later to take up life in the intestines, where they become sexually mature. This, at least, is the theory of Railliet on their development, and it seems to be the best supported of any yet offered.

**Pathology.**—The adult worms are very firmly fixed to the mucous membrane of the intestines by their mouth armature; they form small, dark prominences on the intestinal wall and live on the blood which is drawn from the same. They are believed by some to be the cause of diarræa, colic, etc., but the fact is not yet certainly established. The tumers formed by larval stages appear to be without influence on the health of the animal. Not so with the aneurisms which are very common, and always in the abdominal vessels (Fig. 66). These are very dangerous on account of the risk of rupture and more especially on account of the clots which may break loose or give off parts to be carried by the blood until they block up some small artery. The disturbance produced is proportioned to the size of the vessel stopped up. Immediate anemia of that portion to which the artery affords blood supply is produced; this causes paralysis or suspension of the functions of that area. The result of this is colic which may or may not be fatal. Recurrence of the trouble is not only probable but practically certain. The secondary effect of the aneurism is to diminish the blood supply to the intestines since the clot pre-
vents the free passage of the fluid, and in this way chronic indigestion may arise.

TREATMENT.—Neumann says it is of the highest importance from the above consideration to diminish the extension of the sclerostomes as much as possible. This can only be done by a most careful inspection of the water horses drink, and filtration alone affords reliable security; but the harmfulness of the aneurismal worm is not sufficiently tangible, at least to owners of horses, to permit of a hope that a precaution which would be so contrary to present usages is likely to be adopted.

The free worms can be removed from the cæcum by vermifuges, although this is difficult. In the case of the aneurismal worms, the use of oil of turpentine is said to be beneficial.
Uncinaria duodenalis (Dub.) Raill. 1885.

SYN.—Anchyllostoma duodenale Dub. 1843; Strongylus quadridentatus v. Sieb. 1851; Dochmius anchilostomum Molin 1860; Sel; rostoma duodenale Cobbold 1864; Str. duodenalis Schn. 1866; Dochmius duodenalis Leuck. 1876.

Body pale reddish, cylindrical, slightly smaller in front (Fig. 67); buccal capsule little inflated with two pairs of recurved teeth; two papillae opposite at the anterior sixth of the body. Male 8 to 11 mm. long; caudal sac (Fig. 68) with small dorsal lobes and two prominent lateral lobes; posterior ribs three-parted, middle ones double, anterior ones split; two long spicules. Female 10 to 18 mm. long; tail blunt, prolonged into a slender point; female sexual opening toward the posterior third of the body; eggs elliptical 0.052 by 0.032 mm.

This species inhabits the small intestines of man and has also been found in Italy, France, Austria, Germany, Spain, in various parts of Asia and Africa, and is stated to have been found in America, though I am unable to find where, as the statement is quoted without any authority.

STRUCTURE.—One point in the structure deserves special attention; it is the so-called pharynx or buccal capsule (Fig. 69). This is very nearly spherical and is armed with four strong curved chitinous teeth. At the bottom of the capsule are two triangular lance-like organs, the function of which is the penetration of the tissue.

LIFE HISTORY.—The development of the egg does not go on well in water, but in droppings or in slime progresses rapidly, and the majority of the embryos are hatched in from one to four days. They undergo several molts in the free condition, and, curiously, they do not escape from the molted skin, but use it as a protective covering. In this way they are enabled to endure even extreme dryness and may be transported by the wind. It is probable that they rae taken directly into the human alimentary canal without the intervention of an intermediate host.
PATHOLOGY.—The worms fix themselves to the mucous membrane of the intestines and live on blood extracted from the tissue. Their presence in numbers gives rise to a disturbance known as Egyptian chlorosis or miner’s anæmia. This disease is very common among the miners, having attracted attention by its severity at the building of the Saint Goarth tunnel. Without considering in detail the symptoms of the disease, it may be said that the treatment consists entirely in the observatin of strict sanitary principles. The use of anthelminthics is of little avail since the parasites adhere very firmly by means of their recurved teeth.

_Uncinaria trigonocephala_ (Rud.) and _Uncinaria stenocephala_ Raill. are related species which cause a similar disease in hunting dogs or hounds.

_Uncinaria cernua_ (Creplin) Raill. 1885, has been described by Curtice in his “Animal Parasites of Sheep,” under the name of _Dochmius cernus_. It is closely related to the last mentioned species and inhabits the small intestines of sheep. It lives upon the blood, and the effects of its parasitism should be investigated. Further details on this species may be found in the article quoted above.

_FAMILY OF THE TRICHTRACHELIDAE._—These worms are extremely elongated; the anterior part of the body is very slender, and the posterior more or less enlarged. The males are without any spicules in some cases; in other cases they possess a single simple one.

This family includes some of the best known and most feared of human parasites.
**Trichocephalus dispar** Rud. 1801. (Fig. 70.)

**Syn.**—*Tr. hominis* Schrank 1788; *Ascaris trichura* L. 1771.

Male 35 to 45 mm. long, with spicules 2.5 mm. in length. Female 35 to 50 mm. long; slender portion proportioned to posterior part as two to one; eggs brown, 0.051 by 0.022 mm.

This parasite lives in the caecum of man, but is rarely found in the vermiform appendix and the colon. Ordinarily only a few are present, but they are occasionally more numerous. It is extremely common all over the entire globe. Ordinarily the slender portion of the body is embedded in the mucous, and in general, its presence is not accompanied by any serious trouble. Of course the presence of a large number of the parasites is likely to give rise to serious nervous trouble.

Of the life history it may be said that the development takes place without any intermediate host, and the parasites are introduced by means of drinking water; the entire development occupies a period of four or five weeks.

**Trichina spiralis** Owen 1835.

Male 1.4 to 1.6 by 0.04 mm. Cloacal opening between two caudal appendices; in front of the opening, two pairs of papillae. Female 3 to 4 mm. by 0.06 mm.; anus terminal; sexual openings at the end of the anterior portion of the body; ovoviviparous. The embryos 0.09 to 0.1 mm. by 0.006 mm. In the larval condition, coiled in muscular and adipose tissues, they measure 0.8 to 1 mm. by 0.04 mm.

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Two forms of the *Trichina* are recognized commonly; first, the so-called *intestinal trichina* (Fig. 71), which is the sexually mature form found in the small intestines of many animals; the second is the so-called *muscular trichina* (Fig. 72), which is the larval condition and is found encysted in various
parts of the body. Of the many animals in which the trichina may develop, man, pig, and rat are those easily affected, the mouse, Guinea pig, and rabbit still more easily, while a long list of other forms, including the horse, dog, cat, calf, lamb, etc., are occasionally or very slightly affected. The intestinal trichina may be made to develop in birds, but the larva are not able to penetrate the walls of the intestines, and hence the flesh of the bird does not contain any of the encysted forms. Muscle trichina have never been found in the flesh of fishes or invertebrates; and all statements to the contrary, as well as reports of trichina encysted in vegetable tissue, depend upon confusion with some different species of Nematodes. This confusion renders it all the more necessary to consider very carefully the structure both of the larval trichina and of its cyst, which will be taken up under the life history.

Of all the many animals in which the trichina has been found, it seems some what probable that the rat was its original host. The brown rat, which made its appearance in Europe in 1727, possibly brought the parasite with it from the East, and with the rat the parasite has spread over the entire world.

The muscle trichina was first discovered in 1828, in dissections undertaken in a London hospital. Its connection with the disease it produces, and the stages in its life history were demonstrated in Germany by the researches of Virchow, Zenker, and Leuckart. Leidy discovered trichina in pigs in America in 1847.

Structure.—The sexually mature worm (Fig. 71), seldom comes to the observation of persons other than those experimenting. It differs from the larva (Fig. 73), in the development of the sexual organs and accessory parts. Among the organs of the body the so-called middle intestine, or according to some other authors, the “cell-body” of the oesophagus, deserves especial mention in this place; it is composed of large nucleated cells which are very striking in appearance. This organ, in connection with the size, serves for identifying the species.

Life History.—The life history of trichina is peculiar among all parasites in that it is in most cases, and always normally, probably carried on within the body of the hosts and no part of it is played in the open world. Hence the agency of drinking water, so important in other cases, is unimportant here.
It is difficult to find a perfectly natural point to begin the account of the life history, but perhaps the matter becomes clearest if one starts with muscle trichinae encysted in a piece of flesh. If a rat, for instance, which we may probably regard as the original normal host of the trichinae, be fed some pieces of muscle containing encysted trichinae, the flesh is dissolved by the gastric juice, and the larvae are freed and pass into the intestines. Less than forty-eight hours are required to attain sexual maturity.

The development of the embryos begins in the uterus immediately after copulation, and by the sixth day the embryos are ready and beginning to escape from the female; the males, which are rarer than females, have already begun to leave the intestines with the feces. Recent investigations seem to render it probable that the female intestinal trichinae bore their way into the velvet-like projections, the villi, of the intestinal wall. They are found in all the superficial layers of the wall and sometimes at least partly in the cavities of the much distended chyle vessels, though living trichinae are found in the cavity of the intestines up to twelve weeks after the infection. Here it is probable that they give birth to the many embryos, and for something like a month they continue to bring forth embryos. The number of embryos produced by a single female has been estimated to be from 10,000 to 15,000; these are gradually discharged, possibly in the intestinal walls or blood vessels, but more probably into the cavity of the chyle vessels; in the last embryos have been positively demonstrated in some cases so that we are inclined to believe that the females bring the young into the tissue instead of depositing them into the intestines as was formerly maintained; and that the lymph stream carries them from the intestine. No doubt some of them make their way into the blood current or through the connective tissues by active migration. In these ways they will easily reach parts remote from the intestines in a very short time. The duration of these migrations is said to vary from six to ten days. While the larvae may settle down in almost any portion of the body or in almost any kind of tissue, they are most ordinarily found in the muscles, especially in the vicinity of the bones or tendons by which their migration is arrested. Some authors believe that they develop within the muscle fibers, others inclined to believe that their final location is in the tissues between the fibers.

Having finally reached its resting place the larval trichina increases rapidly in size and coils itself in the shape indicated in the figure. Here its movements result in the formation of a cyst by the irritated tissues surrounding. At first granular substance with some large vacuoles are visible around it (Fig. 72), and later a sheath with a fine deposit of lime becomes apparent. In general the cyst is ovoid, lengthened in the direction of the muscle fibers. In size it is 0.4 by 0.25 mm. but may vary considerably. Commonly only one trichina is found in each place but two, three, four, or five may be seen. The trichina rests within the cyst unchanged for long periods of time, being found alive according to Damon eleven years after introduction in pork and from 13 to 24 years in man. Neumann remarks, however, that the possibility of new infections between times has not been disproved. In the course of time the cyst may undergo degeneration; this may be either by the addition of the pigment granules or by fatty or calcareous degeneration. Cysts which have become calcareous are very frequently met with in the flesh of both pig and man.
The encysted trichina may be distinguished from other forms of Nematodes encysted in tissue by means of the "cell-body" so-called which may be made visible by proper treatment.

The larva lies dormant in its cyst until the flesh is eaten by some animal, when the cycle is begun again with the development of the sexually mature intestinal trichina. It is not impossible that the trichina might be acquired through the means of those intestinal trichina which may be evacuated from the intestine of an animal that has become infected and through their accidental importation into the alimentary canal of some suitable host. In this way it is possible that a pig may become slightly infected by eating the dung of a diseased rat. Such instances as these have been produced experimentally but are necessarily rare, and in the majority of cases the worms are introduced into the intestines of the hog by the eating of rats or refuse from slaughtered animals which were themselves infected.

Pathology.—There are two forms of trichinosis or trichiniasis, the one due to the larvae in the muscles, the other due to the eating of infested flesh, the development of the sexual form in the intestine, and the wandering of the embryos to the muscles. The disease is much more frequent in the pig than in any other of the domesticated animals. Its symptoms are displayed only when the quantity introduced is large, and hence in the majority of cases the disease will escape notice. Intestinal trichinosis is the cause of the first disturbances which appear in four to ten days after eating trichinous flesh; loss of appetite, thirst, fever, diarrhea of a persistent character, sometimes vomiting, are symptoms which may manifest themselves in cases, but in all these there is little characteristic of this particular disease.

Following this, symptoms of muscular trichinosis due to the wanderings of the worms are observed from the eighth to the fifteenth day. These include muscular troubles such as stiffness, pain in the muscles, and difficulty in movement, especially in mastication and respiration. The last period which follows the encystment of the larva is characterized by cachexia and extreme anemia. Edema appears in many places and is usually followed by the death of the animal. Nearly all the hogs attacked gradually recover however. The duration of the disease varies naturally with the degree of infection; in light cases it is about two to three months.

These doubtful or often scarcely visible symptoms make the diagnosis very difficult and usually impossible. A harpoon has been invented for obtaining a sample of the muscle in order to diagnose the disease from the presence of the larva. The thick layer of fat found beneath the skin renders the use of the instrument rather difficult.

Unless the infection is severe the muscles are very unequally filled with the trichinae. Kauhn showed that the diaphragm is most seriously infected; after that in less intense way the shoulder muscles, the psoas muscles, larynx, neck, tongue, etc. In order to ascertain the presence of trichinae the muscle should be taken from the part most seriously infected; Neumann recommends the following method: a small piece of muscle is cut parallel to the direction of the fiber; after lying in water a short time it is pressed between two glasses, and will show the cysts under a magnifying power of 100 to 150 diameters. It is better, however, first to tease the fibers in water by needles and then examine in the normal salt solution (see appendix A) or in a 0.1 to 0.5 of one per cent solution of acetic acid.
A single animal may contain a truly enormous number of cysts; in an ounce of flesh Leuckart has estimated between 200,000 and 225,000, which would make the total number in the body about forty millions. Others have estimated from five to one hundred millions in the body of a single patient. In this way an approximate idea of the severity of the infection may be obtained.

The life history makes it clear that the disease must always be due to the introduction of trichinous meat or of worms or embryos from excrement. It is, hence, of importance to establish the proportion of trichinae in different animals and different localities. It has already been stated that the rat is probably the original host of the trichinae. The number of rats infected with trichinae is said to be for Paris about 7 per cent, for Germany, from 3 to 50 per cent, while Neumann quotes from a source which I am unable to learn, the statistics for Boston of from 6 per cent in stable rats to 70 per cent in slaughter house rats. The proportion of pigs infected with trichinae is 12 per thousand in Russia, 4 to 15 in Sweden, 0.1 to 0.13 in the German Empire.

For the United States there is no official register of any sort, and for evident reasons the reports are somewhat widely at variance. One can hardly too strongly criticize the ignorance or maliciousness of the foreign consul at Philadelphia who stated in an official report to his government that in Illinois alone trichinosis killed 700,000 pigs in 1880, kindly including in the total the mortality due to the hog cholera! Equally wild and unsubstantiated are the reports commonly current in European journals to the effect that 70 to 80 per cent of American hogs are infected. On the other hand, the claim advanced by some persons that trichinosis is unknown to this country is certainly untrue. One undoubted case of death from trichinosis within this State has come under the writer's observation. It is of the greatest importance that the system of meat inspection should be widely introduced, and that the actual state of the case should be made known. Not only that the pork exporting firms suffer seriously from the believed prevalence of trichinosis, but also the meat consumers have a right to demand exact knowledge with regard to the flesh which is offered for sale.

Meat inspection is most rigorously and scientifically carried out in Germany where trained examiners report upon the condition of every animal killed. For trichina the method employed is that already suggested—the examination of a small part of the muscle from some special region with a view to detecting the presence of trichinous cysts. The meat is also examined at the same time with reference to the occurrence of the other parasites.

The disease may be contracted by man through the consumption of flesh containing living larvae only. Both the intestinal phase and the muscular phase are similar in general symptoms to those of the pig. Epidemics have been reported in widely separated places in various countries. They are especially numerous in such regions in Germany where raw pork in various forms is eaten.

**TREATMENT.**—Trichinosis is rarely a serious disease for the pig, but becomes exceedingly so for the consumer of the flesh which has had the attack. So far as preventive means are concerned they will depend naturally upon the vitality of the trichinae in the cysts. Extended experiments have been made by many observers with reference to the temperatures required to kill the para
It has been found that cold is very unreliable, but that a temperature of 55° C. (135° F.) is high enough to kill. It is necessary, however, that the entire mass should reach this temperature in order that the worms in the center are certainly destroyed. Fjord has conducted some experiments which show that the time of cooking necessary to kill the trichinae in the center of a piece of pork is proportional to its size; fifteen to eighteen minutes should be used for each pound of flesh, less half the time necessary to bring the water to a boil. A ham weighing ten pounds should therefore be boiled eighteen minutes i.e., three hours, if put into boiling water, or two hours and one-half if an hour is required to bring to the boiling point the water into which the ham is put.

Roasting should also be careful and complete; so as not to leave in the center raw or half-done portions. Practically one may judge of the safety limit by the entire loss of the reddish color and the absence of any reddish fluid under the action of a knife. The effect of salting is somewhat uncertain. When the process is thoroughly carried out the trichinae are apparently killed. But in a very large number of cases the pickle does not penetrate to the center of the piece and even after a long time living worms may be found there. Smoking during three days and more is usually sufficient to kill all the worms.

In order to suppress the parasite more care must be exercised with reference to the feeding of the pig. The conditions found by Calvin in Iowa show that the swill-fed pigs are very largely infested while the corn-fed swine are almost free. Since at least 95 per cent of the animals killed by our packing houses for exportation are grain-fattened, the chance of obtaining trichinized meat is hardly sufficient to warrant the absolute prohibition placed upon it by some European governments. To quote also from Neumann, “It may be mentioned that as the result of an exhaustive discussion in 1884 the Académie de Médecine and the Société de Médecine Publique decided that the importation of American salt pork of the type fully cured offered no danger.” There is little doubt that the prohibitive measures are largely political and do not depend to any extent upon a scientific study of the subject.

In conclusion it may be said that care in the tending and feeding of the swine will tend to lessen the disease and equal care in cooking will remove danger of human infection. Cured ham must be carefully examined or obtained from some source where the microscopical examination is known to have been made beforehand.

**Family of the Filarideae.**—The body is thread-like, of considerable length; the mouth and mouth capsule are variable; the oesophagus is not provided with a bulb at its end; the male possesses a single spicule or two unequal spicules, and the tail of the male is ordinarily somewhat coiled. The female sexual opening is located towards the front of the body.

The most famous member of this group is without doubt the *Filaria* of Medina, a worm of more than half a meter length, and of uniform diameter throughout, which occurs as a parasite just beneath the skin of man in tropical countries; from this position it is removed by being carefully wound about a small stick, an operation in which the negroes of that country are said to be very expert. It has been introduced into South America, probably by the negroes. Since this worm is not found in temperate regions it may he passed here with the mere mention.
**Filaria immitis** Leidy 1856.

*Syn.*—*F. papillosa, hematica canis domestici*, Gruby and Delafond, 1852.

Body white, obtuse at both ends, the anterior being somewhat thicker than the posterior (Fig. 74). Mouth with six small, indistinct papillae; male 12 to 18 cm. long; tail with two lateral wings and 11 papillae on each side; two unequal spicules. Female 25 to 30 cm. long, 1 mm. broad; tail short and blunt; the female sexual opening only 7 mm. from the mouth. Ovoviviparous embryo (Fig. 75) 0.285 by 0.005 mm., with the posterior extremity tapering to a very slender fine pointed tail.

The so-called “cruel” *Filaria* inhabits chiefly the right side of the heart and the pulmonary artery of the dog. It is frequent in China, Japan, and not uncommon in Europe, North and South America.

**Pathology.**—It appears to frequent particularly hunting dogs, and those of some size, and its presence is not often made known by any disturbance in the health of the animal. It may, however, be detected by microscopical examination of the blood, in which case the delicate embryos will be discovered. Curiously enough, it has been discovered by Manson, that these embryos abandon the surface circulation during the day and appear in it at night.

Frequently the death of the animal is sudden, but convulsions, or even appearance of madness, may precede death. If the heart of the dog be examined, the right side and the arteries for some distance will be found to contain bundles of the worms tied up in extricable knots. The males are ordinarily only half as common as the females, but cases are on record in which only males and only females have been found.

The disturbance in the circulation is not unfrequently accompanied by lung and kidney troubles.

The life-history is unknown, and no treatment, medical or preventive, can be suggested.
**Filaria Bancrofti** Cobbold 1877.

**SYN.—** *Trichina cystica* Salisbury 1868; *F. sanguinis hominis* Lewis 1872; *F. dermathemica* da S. A. 1875; *F. Wuchereri* da S. L. 1877; *F. sanguinis hominis nocturna* P. Manson 1891.

Body white, hair-like (Fig. 76), smaller towards the ends; mouth without papillae. Male, 83 mm. long, 0.4 mm. wide; tail curled up; four pairs of preanal papillae, two unequal spicules. Female 155 mm. long, 0.7 mm. thick; female sexual organs 2 to 3 mm. from the head; eggs, 0.038 by 0.014 mm.

This parasite in the adult condition is found in the heart and lymphatic vessels of man. It is common in the warmer regions of the earth and has been found in individuals from those regions who have gone to colder places. It is especially common in Brazil. The female is ovoviviparous, and the embryos are found in the blood. Like the *Filaria* of the dog, they are found in the surface circulation only at night. The further development is believed to take place with the aid of a mosquito. They are according to Manson removed from the surface vessels of man at night by the mosquito, and undergo certain changes in its alimentary canal, later to reach stagnant water in the eggs of the mosquito, and thence reach the human system through drinking water. The disturbances which are caused by the presence of the *Filaria* are varied, depending upon conditions of race, age, and locality, and the medical treatment has not yet been discovered. Of course the preventive treatment depends upon use of pure or filtered drinking water.

We pass a large number of related forms to mention briefly some species of Nematodes which are parasitic on different forms of plant life. These are included in the family of the Anguillulidae. They are characterized by small size, and thread-like body; the mouth cavity is provided with a piercing apparatus or with teeth; the esophagus has one or two bulbs; the male has two spicules; the females are ovoviviparous and often produce only a small number of eggs. Most members of the family live free in water or earth, some in fermenting substances, like the well-known "vinegar eel" and "paste eel," and a few are parasites of plants.

**Anguillulina tritici** (Bauer) Gerv et Ben. 1859.

**SYN.—** *Vibrio tritici* Bauer 1823; *Tylenchus tritici* Bastion 1864; *Anguillula tritici* Dav. 1856; *A. scandens* Schn. 1866.

Body pale, cylindrical; the esophagus with two bulbs, anterior one fusiform, posterior spherical; male slender, 2.5 mm. long, 0.1 mm. wide; tail provided with a large sac; spicules separate; female thicker, rolled into a spiral, 3 mm.
long, 0.25 mm. wide; female sexual opening just in front of the anus; eggs 0.08 mm. long.

This worm is the cause of the "eelworm disease" of wheat; the kernels of grain if examined are seen to contain about a dozen of the worms in the center, and the grains themselves are distorted and useless. If these are sown, the worms escape, develop, climb the stalk of growing grain in the tissue, and lay their eggs in the developing "ears" where the larva are hatched. As a matter of fact, the apparent grains in which they are found are actually galls developed on different parts of the flower, the effect of which is to destroy the grain.

This species is very destructive in some European countries, but, so far as I have been able to learn, has not been found in this country.

Closely related species are parasitic on rye and buckwheat.

**Heterodera radicicola** (Greeff) Müller 1884.

**Syn.** — *Anguillula radicicola* Greeff 1872; *Ang. arenaria* Neal 1889 (in part).

In the southern states, particularly Florida and Alabama, much trouble has been caused by "root galls" on various cultivated plants. According to the investigations of Neal, and especially Atkinson they are widely distributed. The latter gives a list of thirty-six plants from the vicinity of Auburn, Ala., which are affected by these Nematode root galls; the list includes peach, grape, egg plant, parsnip, turnip, cotton, lettuce, and beet somewhat infected, and potato, tomato, sunflower, water melon, parsnip, and cabbage seriously infected.

While it is probably that the cold winters of this state would kill the parasites and prevent the disease from becoming serious, yet it may prove troublesome in green-houses and hot-beds even this far north. For this reason I include a brief description of the infected plants quoted from Atkinson (Bull. 9, Agl. Exp. Station, Auburn, Ala).

"The abnormal growths on the tomato root appear as irregular fusiform, knotty, or nodulate enlargements, two to ten times the natural diameter of the roots. The surface of the gall is at first smooth, more or less undulate, or papillate, but becomes later roughened, scurfy or cracked, and finally decay of the tissue sets in. The tap root and the earlier lateral roots are attacked early in the season. When the roots begin to die they send out new roots in the efforts of the plant to recover from the effects of the disease; these roots are attacked in turn and deformed. Other plants were found with the tap root still alive, very much enlarged and cracked, and the disease in an active state. The enlargements of the roots of the Irish potato are similar in form though on the specimens which I have examined they are not so numerous or large. The surface of the affected tubers first presents minute elevations usually at the point on the surface corresponding to a lenticel. The minute elevation soon grows to be quite a large convex elevation and finally cracks. There is great variation in the form of the galls, even in the same species."

Experiments as to the best method of meeting the difficulty are almost lacking; suggestions are made as to the sterilization of the soil by starvation, with proper rotation of crops, clean cultivation, and perhaps the use of "trapping" plants, which, planted early and attracting the young worms, can be
pulled up and then burnt with the worm adhering to the roots. This method has proved successful in the case of a related species which attacks the sugar beet in Germany.

Other closely related species are parasitic in the leaves of plants, especially of green-house and cultivated plants. An illustration of such an eel worm and of the appearance of the infected leaves is given (Fig. 77). Violets, chrysanthemums, begonias, roses, etc., are among the species attacked. It is difficult to suggest any preventive method which could be applied on a large scale and which will prove absolute. In case of those who may meet the trouble in small beds of plants, it may be suggested that a change of soil is beneficial and that the baking of the soil in which the plants are to be put will be an absolute preventive. The use of lime water, sulphur, and other substances not injurious to the plant but fatal to the worm has been suggested. A similar trouble due to another species has been met with by strawberry growers, but
is not likely to be dangerous in this climate. The German sugar beets have been attacked by a species that is parasitic on the beet root; this is not at present in our country and is mentioned to call attention to the necessity of avoiding the importation of beet-roots or soil by which the worms might possibly be introduced. They could not, however, be imported in the seed.

The family of the Angiostomidae is interesting as it is composed of the so-called "heterogenic" forms, that is to say, those which have two sexual generations succeeding each other irregularly, one of which is dioecious and free, the other hermaphroditic and parasitic.

**Strongyloides intestinalis** (Bavay) Grassi 1883.

*Syn.* — *Anguillula stercoralis* and *A. intestinalis* Bavay 1877; *Leptodera stercoralis* and *L. intestinalis* Cobbold 1879; *Pseudorhabditis stercoralis* Perr. 1881; *Rhadinema strongyloides*, Leuck. 1883; *Rh. intestinalis* R. Bl. 1885.

The intestinal female is 2.2 mm. long, and 0.034 mm. broad; the body is slightly smaller in front; the tail conical, slightly enlarged at the end; mouth with three small lips, the oesophagus cylindrical, one-fourth the length of the body and continuous with the intestine without any constriction. The female genital opening lies in the posterior third of the body. The uterus contains six to nine eggs, elliptical, 0.054 by 0.032 mm. Free-form both males an females; body cylindrical, tapering to the ends, especially toward the tail; mouth with three lips; oesophagus with two bulbs separated somewhat from each other; male 0.7 by 0.035 mm.; tail curved, two spicules; female 1 mm. by 0.050 mm.; sexual...
opening slightly in front of the middle of the body; eggs elliptical, 0.070 by 0.045 mm., sometimes hatching in the uterus. The intestinal form is parasitic in man, and appears to be distributed over the warmer portion of the entire world.

LIFE HISTORY.—The two forms were regarded as distinct species until the work of Leuckart showed that they were merely successive generations. In the human intestines one finds only the intestinal form and its embryos. The adults are females alone (Fig. 78), and are present ordinarily in enormous numbers. It is probable that the eggs develop without being fertilized, and the embryos are hatched in the intestines to be discharged with the faces. When they reach the outside they moult, and in the old skin, which is not cast off, as a protection from the dryness, they may be transported by circumstances to a considerable distance. If the temperature, however, is high they mature into the free sexual generation (Fig. 79), and within a very short time the female lays thirty or forty eggs, which develop very rapidly. At the end of two weeks all of the free generation are dead, and their larvae have gone through a series of changes which make them resemble the intestinal form; in this condition (Fig. 79, C) they live hardly more than five or six days and perish if they do not re-enter the human intestines.

PATHOLOGY.—The enormous number of the parasites cannot fail to have a serious effect upon the digestive system. It is, however, questioned whether they are the real cause of the disorders with which they are usually connected or whether perhaps they may render the troubles more serious. Investigators in Italy are of the opinion that they produce, when present in large numbers, an intense enteritis.

A species somewhat similar to this has been found in the intestine of the sheep; it is slightly larger, but otherwise very similar. It is not known to cause any particular trouble.

The sub-order of the Gordiacea, the second group of round worms, is distinguished by the degenerate condition of the alimentary canal in the adult. These forms are familiarly known as "hair snakes" or "hair worms," and popular superstition believes them to originate from horse hairs which have fallen into water. In reality, the early life of the worm is passed in the body of some insect, such as the grasshopper, and they escape into the water when mature. Here the eggs are deposited and the larva later reach the insect. According to some they are also parasitic in fish. A further account of their structure and their life history hardly belongs here.

Order IV.—ACANTHOCEPHALA.

The fourth order of round worms, the Acanthocephala, or "Thorny-headed" worms, includes an important and dangerous parasite to domestic swine, and others found in birds and fishes. They are characterized by the entire absence of the alimentary canal and by the presence of a protractile proboscis armed with hooks.
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Fig. 80.—Gigantorhynchus gigas from Lincoln; male at left, female at right. Half natural size. (Original.)

Fig. 81.—Head of Gigantorhynchus gigas; magnified. (Original.)

Gigantorhynchus gigas (Goeze) Hamann 1892.

Syn.—Tenia hirudinacea Pallas 1781; Echinorhynchus gigas Goeze 1782.

Body milkwhite, sometimes slightly tinted, with transverse irregular ridges. Posterior end somewhat smaller; proboscis spherical, armed with five or six rows of hooks. The proboscis can be retracted into a neck-like region which is much slimmer than the following portion of the body. Male 60 to 90 mm. by 3 to 5 mm. with bell-shaped caudal pouch. Female 230 to 350 mm. by 4 to 9 mm.; tail blunt; eggs almost cylindrical 0.087 to 0.1 mm. long with three embryonic envelopes.

The adult worm is found in the small intestine of the pig, ordinarily fixed to the wall by the proboscis. It occurs in Europe and in the United States, and is present in almost all the pigs slaughtered in Lincoln.

Structure.—The elongated body (Fig. 80) is largest near the head and tapers gradually towards the posterior end. At the anterior end a sharp constriction separates the body from the short neck-portion which is not more than one-fourth or one-fifth the diameter of the body close to it. From the apex of this region may be projected the proboscis which is contained within it, like the reversed finger of a glove. As the proboscis rolls out, the hooks also turn outward, and when the proboscis is completely extruded the shape of the organ (Fig. 81) is nearly that of a sphere on which are from five to six irregular rows of hooks. Behind these the proboscis is slightly smaller.

If the internal structure be examined it will be seen that the proboscis is provided with retractor muscles by means of which it may be withdrawn into the body. At the base of the proboscis is the small mass of nervous matter which represents the brain.
There is no trace of an alimentary canal, hence these forms, like the tapeworm, take nourishment by absorption. Two elongated sac-like organs hang down into the body cavity along the sides of the proboscis. These are the lemnisci (L, Fig. 82); their function is uncertain.

The mass of the body is made up of the organs of the reproductive system. Unlike those parasites thus far considered all of this order have separate sexes. The male organs (Fig. 82) consist of two large testes (T) together with the ducts and accessory glands (S, V.) connected with them. The tail of the male has a hemispherical expansion, something like the caudal sac of other round-worms; the male sexual opening in the center of this sac at the tip of the body is provided with a small copulatory organ. The internal sexual organs of the female are much similar in general appearance; the ovaries lie toward the front of the body cavity which is largely filled with eggs in various stages of development. These are discharged by the oviduct which opens at the posterior end of the body.

Life History.—The eggs of the *Gigantorhynchus* are discharged from the alimentary canal of the host and spread over the ground with manure. The eggs are eaten by some insect and hatched in its intestines. The embryo which has a conical form armed at one end with four hooks like tapeworm hooks, and a number of smaller ones, penetrate into the abdominal cavity of the insect and encysts there. In this condition they remain and may even live through the metamorphoses of the insect until the host is eaten by some pig. In the alimentary canal of the pig the embryo is set free, attaches itself and acquires maturity. There is some dispute as to what insect is the intermediate host; the white worm-like larva of the May bug and the larva of the common rose chafer have been found to contain these worms, and Stiles has experimentally infected the larvae of the June bug in this country. It is also maintained that various species of snail may function as the larval host. In all probability the larva is not confined to a single host, but may develop in many.

Pathology.—The wall of the intestine will necessarily be irritated at the points where the worms are attached; and these points of attachment produce small abscesses. It is not strange, then, that the parasites cause considerable disturbance in the digestive functions, producing debility, restlessness, emaciation, and sometimes spasms and convulsions. The subject, however, seems to have been investigated very little, and I am able to find almost nothing on the character of the disease, and, with regard to treatment, only the statement that it is still to be experimented upon. Undoubtedly the worm would be difficult to dislodge on account of the powerful proboscis. I think it desirable that some more definite studies in the life history and frequency of the worm should be made in order to determine the actual amount of damage done by it. In Germany it is said to occur in one pig out of every four, and some authors believe that it is becoming rarer. In this connection may be mentioned the statement of Leuckart that it appears only in those pigs which feed in the open air. With the introduction, then, of pen-feeding it might be expected to grow rarer. In those regions, however, where the animals are allowed the free-
dom of a considerable piece of territory the parasites would probably be more abundant. I am inclined to believe then they are more common in our western states than they are in the East; but the observation rests on slight experience in a very limited number of places. At least the subject deserves investigation.

PART III.—CHECK LISTS OF PARASITIC WORMS.

Much of the difficulty of reading intelligibly works treating of the various parasites is due to the confusion of names encountered. Anyone will see that all value in scientific names would be lost if every man could give a name to any animal he found whether the form were old or new; and zoologists have in various international congresses formulated and elaborated the rules of nomenclature to govern the rights of the original discoverer. It is not surprising, however, that forms are not always recognized as old and that the synonymy has grown to be somewhat complex. At much labor and with the assistance of similar lists published in the past, I have made a full record, I believe, of the parasites of man, cattle, sheep, horse, and dog, and append them to this report for the convenience of all who are working or reading on these subjects. By reference to the list under the name used by any writer, the correct name can be found, the date at which the name was given, the author naming the parasite, and the part or organ of the host in which it is found. It would be impossible to enumerate all the sources from which information was gathered. I am, however, particularly indebted to the works of Leuckart, Railliet, Neumann, and Von Linstow, and to a long list sent by Dr. Stiles of the Bureau of Animal Industry, Washington. On species found in the United States the papers of Stiles, Curtice, Welch, and Francis have been consulted.

ABREVIATIONS USED IN LISTS.

- * Found in North America in the host cited.
- ** Found in Nebraska.
- ? Doubtful species, or doubtful host for this species.

All synonyms refer to correct name under which are given details on location, distribution, etc. Larval forms are listed under adult with cross reference from larval name if a special one is used.

Order followed: (1) Name of parasite.
(2) Name of author who gave the name used.
(3) Date at which named.

Name of an author in parentheses denotes original describer of species; name after parentheses is name of author who included this species in the present genus.

Parasites of Man (Homo sapiens L.)

Trematodes.

*Amphistomum hominis* Lewis and McConnell 1876; cæcum and colon.
*Bilharzia haematobia* Cobb. 1859, see *Gyncephorus haematobius*.
*Cladocelium hepaticum* Stossich 1892, see *Fasciola hepatica*.
**Dicrocelium Buski** Weinl. 1858, see *Distoma Buski*.
* heterophyes* Weinl. 1858, see *Distoma heterophyes*.
* oculi humani* Weinl. 1858, see *Distoma ophthalmobium*.

*Distoma Buski* Lankester 1857; duodenum.
* capense* Harley 1864, see *Gynacophorus haematobius*.
* cavie* Sonsino 1890, see *Fasciola hepatica*.
* conjunctum* Cobb. 1859; biliary ducts.
* conus* Gurit 1831, see Creplin 1825, see *D. felineum*.
* crassum* Busk 1859, nec v. Sieb. 1836, see *D. Buski*.

**felineum** Riv. 1884; biliary ducts.
* haematobium* Bilharz 1852, see *Gynacophorus haematobius*.
* hepaticum* Retzius 1786, see *Fasciola hepatica*.
* hepatis endemicum* Bælz 1883, see *D. sinense*.
* hepatis innocum* Bælz 1883, see *D. sinense*.
* heterophyes* v. Sieb. 1852; small intestine.
* japonicum* R. Blanch. 1886, see *D. sinense*.
* lanceolatum* (Rud.) Mehlis 1825; biliary ducts.
* oculi humani* v. Amnon 1833, see *D. ophthalmobium*.
* ophthalmobium* Diesing 1850; eye; perhaps young *D. lanceolatum*.
* pulmonale* Bælz 1883, see *D. Westermanni*.
* pulmonis* K., S. and Y. 1881, see *D. Westermanni*.
* Rathouisi* Poirier 1887; biliary ducts (?); perhaps *D. Buski*.
* Ringeri* Cobb and Manson 1880, see *D. Westermanni*.
* sibiricum* Winogradow 1892, see *D. felineum*.
* sinense* Cobb. 1875; biliary ducts.
* spathulatum* Leuck. 1876, nec. Rud. 1819, see *D. sinense*.
* haematobium* Bilharz 1852, see *Gynacophorus haematobius*.
* Westermanni* Kerbert 1878; lungs, rarely also encysted in connective tissue.

*Fasciola hepatica* L. 1758; biliary ducts.
* heterophyes* Moq.-Tand. 1860, see *Distoma heterophyes*.
* humana* Gmelin 1789, see *F. hepatica*.
* lanceolata* Rud. 1803, see *Distoma lanceolatum*.
* ocularis* Moq.-Tand. 1862, see *Distoma ophthalmobium*.

*Festucaria lentis* Moquin-Tandon 1860, see *Monostoma lentis*.
* Gynacophorus haematobius* (Bilharz) Dies. 1858; blood vessels, especially portal veins.

*Hexathryridium pinguicola* Treutler 1793; ovary.
* venarum* Treutler 1793; veins.

*Mesogonimus heterophyes* (v. Sieb) Raill. 1890, see *Distoma heterophyes*.
* Westermanni* (Kerb.) Raill. 1890, see *Distoma Westermanni*.
* Monostoma lentis* v. Nordmann 1832; lens of eye.
* Schistosoma haematobium* Weinl. 1858, see *Gynacophorus haematobius*.
* Thecosoma haematobium* Moq.-Tand. 1860, see *Gynacophorus haematobius*. 
CESTODES.

Bothriocephalus cordatus Leuck. 1862; intestine.

cristatus Davaine 1874; intestine.

latus Bremser 1819; small intestine.

liguloides Leuck. 1884, see B. Mansoni.

Mansoni (Cobb,) R. Bl. 1886; connective tissue and body cavity.

* Cysticerкус acanthotrias Weiland 1858; larva of unknown Tænia.

*cellulosae Rud.; larva of Tænia solium.

tenuicollis Rud.; larva of Tænia marginata.

Davainea madagascariensis (Dav.) R. Bl. 1891; intestine.

Dibothrium latum Dies. 1850, see Bothriocephalus latus.

cordatum Dies. 1850, see Bothriocephalus cordatus.

Diplacanthus nanus Weinland 1858; see Hymenolepis nana.

Dipylidium caninum (L.) Raill. 1893; small intestine.

*Echinococcus polymorphus Dies.; larva of Tænia echinococcus. [This form has been described by different authors as at least a dozen different species; without quoting these names here it is enough to say that all are the one somewhat variable species given above.]

*Hymenolepis diminuta (Rud. 1819) R. Bl. 1891; jejunum.

flavopunctata Weinl. 1861, see H. diminuta.

nana (v. Sieb.) Leuck. 1863; small intestine.

Ligula cingulum Rud.; intestine (fragments of a Tænia?).

Mansoni Cobb. 1883, see Bothriocephalus Mansoni.

Tænia aegyptiaca Bilharz 1852, nec Krabbe 1869, see Hymenolepis nana.

canina L. 1767, nec Batsch 1786, see Dipylidium caninum.

cucumerina Bloch 1782, see Dipylidium caninum.

diminuta Rud. 1819, see Hymenolepis diminuta.

echinococcus v. Sieb. 1853; larva encysted in various organs.

eolithica Batsch 1786, see Dipylidium caninum.

flavopunctata Weinl. 1858, see Hymenolepis diminuta.

inermis Moq.-Taud. 1860, see T. saginata.

lata L. 1748, see Bothriocephalus latus.

leptocephala Creplin 1825, see Hymenolepis diminuta.

madagascariensis Davaine 1869, see Davainea madagascariensis.

marginata Batsch 1786; larva encysted in peritoneum, pleura, etc.

mediocanellata Köchenm. 1852, see T. saginata.

megalocon Weinland, see T. saginata.

minima Grassi 1886, see Hymenolepis diminuta.

moniliformis Pallas 1781, see Dipylidium caninum.

nana v. Sieb. 1852, nec v. Bened. 1862, see Hymenolepis nana.

officinalis, see T. solium.

pellucida Goeze 1782, see T. solium.

prima Plater 1603, see Bothriocephalus latus.

*saginata Goeze 1782; small intestine.

*solium (L.) Rud. 1810; small intestine, larva encysted in muscles and viscera.
NEMATODES.

Anguillula intestinalis Bavay 1877, see Strongyloides intestinalis.

lepoptera Nielly 1882; skin.

Ankylostoma or Anchyllostoma duodenale Dubini 1843, see Uncinia duodenalis.

Ascaris alata Bellingham 1839, see A. mystax.
apri Gmelin 1789, see Strongylus paradoxus.
brachyoptera Rud. 1819, perhaps A. mystax.
canis Schrank 1788, see Dioctophyme gigas.
cati et canicula Schrank 1788, see A. mystax.
felis Bruguière 1791, see A. mystax.
leptoptera Rud. 1809, in part A. mystax.

*lumbricoides L. 1758; small intestine.

marginata Rud. 1802, see A. mystax.

maritima Leuck. 1876; intestine or stomach.
martis Schrank 1788, see Dioctophyme gigas.

microptera Rud. 1819, perhaps A. mystax.
mystax (Zeder.) Rud. 1802; small intestine.
renalis Gmelin 1789, see Dioctophyme gigas.

trichiura L. 1771, see Trichocephalus dispar.
tricuspidata Bruguière 1791, see A. mystax.

triquetra Schrank 1790, see A. mystax.

vermicularis L. 1767, see Oxyuris vermicularis.

visceralis Gmelin 1789, see Dioctophyme gigas.

Werneri Rud. 1793, see A. mystax.

Cheiracanthus siamensis Levinsen 1889, see Gnathostoma siamense.

Eustrongylus gigas (Rud.) Dies. 1851; see Dioctophyme gigas.

visceralis Raill. 1885, see Dioctophyme gigas.

Dioctophyme gigas (Rud.) Coll. Meyn. 1802; kidney.

Dochmius anchylos'omum Molin 1860, see Uncinia duodenalis.

duodenalis Leuck. 1876, see Uncinia duodenalis.

Dracunculus loa Cobb. 1864, see Filaria loa.

medinensis Cobb. 1864, see Filaria medinensis.

oculi Dies. 1860, see Filaria loa.

Persarum Kämpfer 1694, see Filaria medinensis.

*Filaria Bancrofti Cobb. 1877; lymphatic vessels and heart.

conjunctivae Addario 1885; eye.
dermathemica da Silva Araujo 1875, see F. Bancrofti.
diurna Manson 1891; larva (perhaps F. Bancrofti); blood.
hominis bronchialis Rud. 1819, see F. lymphatica.

*hominis oris Leidy 1850; from mouth.

inermis Grassi 1887, see F. conjunctivae.
**Filaria labialis** Pane 1864; female in upper lip.

*loa* Guyot 1778; eye.

**lymphatica** (Treutler) Moq.-Tand. 1860; lymph glands.

**mediënsis** (Velsch) Gmelin 1789; subcutaneous connective tissue.

**oculi hominis** v. Nord. 1832, see *F. lentis*.

**palpebralís** Pace 1867, nec Wilson 1844, perhaps *F. conjunctivae*.

**peritoxa hominis** Babes 1880, see *F. conjunctivae*.

**perstans** Manson 1891; larva of unknown adult; blood.

*restiformis* Leidy 1880; urethra, found only once.

**sanguinis** Lewis 1872, see *F. Bancrofti*.

**sanguinis hominis**, see *F. Bancrofti*.

**sanguinis nocturna** P. Manson 1891, see *F. Bancrofti*.

**Wuchereri da Silva Lima** 1877, see *F. Bancrofti*.

**Fusaria mystax** Zeder 1800, see *Ascaris mystax*.

**vermicularis** Zeder 1803, see *Oxyuris vermicularis*.

**Gnathostoma siamense** (Levinsen) Raill. 1893; tumors on chest.

**Gordius pulmonalis** apri Ebel 1777, see *Strongylus paradoxus*.

**Hamularia lymphatica** Treutler 1793, see *Filaria lymphatica*.

**Leptodera intestinalis** Cobb. 1879, see *Strongyloides intestinalis*.

**Metastrongylus longevaginatus** Molin 1860, see *Strongyloides longevaginatus*.

**paradoxxus** Molin 1860, see *Strongyloides paradoxus*.

*Oxyuris vermicularis* (L.) Bremser 1819; cæcum.

**Pseudorhabditis stercoralis** Perroneito 1881, see *Strongyloides intestinalis*.

**Rhabditis genitalis** Scheiber 1880; probably *R. pellio*, found only once in urine; accidental?

**Niellyi** R. Bl. 1888; larvae in pimples.

**stercoralis** Babay, see *Strongyloides intestinalis*.

**Rhabdonema intestinalis** R. Bl. 1885, see *Strongyloides intestinalis*.

**strongyloides** Leuck. 1883, see *Strongyloides intestinalis*.

**Seléostoma duodenale** Cobb. 1864, see *Uncinaria duodenalis*.

**Strongyloides intestinalis** (Babay) Grassi 1883; intestine.

**Strongylus duodenalis** (Dub.) Schneider 1866, see *Uncinaria duodenalis*.

**elongatus** Duj. 1845, see *S. paradoxus*.

**gigas** Rud. 1802, see *Dioctophyme gigas*.

**longevaginatus** Dies. 1851, see *S. paradoxus*.

**paradoxxus** Mehlis 1831; bronchi.

**quadridentatus** v. Sieb. 1851, see *Uncinaria duodenalis*.

**renalis** Moq.-Tand. 1860, see *Dioctophyme gigas*.

**suis** Rud. 1809, see *S. paradoxus*.

**Trichina cystica** Salisbury 1868, see *Filaria Bancrofti*.

**spiralis** Owen 1835; adult in small intestine, larva encysted, especially in muscles.
Trichocephalus dispar Rud. 1801; caecum.
    hominis Schrank 1788, see Tr. dispar.
Uncinaria duodenalis (Dub.) Raill. 1885; small intestine.
    Vena medinensis Velsch 1674, see Filaria medinensis.

Acanthocephala.

Echinorhynchus gigas Goeze 1782, see Gigantorhynchus gigas.
    hominis Lamb. 1859; small intestine.
?Gigantorhynchus gigas (Goeze) Hamann 1892; small intestine.

Parasites of Cattle (Bos taurus L.).

Trematodes.

Amphistoma conicum (Zeder) Rud. 1809; first stomach.
    crumeniferum Creplin 1847, see Gastrothylax crumeniferum.
?explanatum Creplin 1847; stomach.
    tuberculatum Cobb. 1875; intestine.
    Bilharzia bovis Sonsino 1876, see Gynacophorus crassus.
    crassa Sonsino 1877, see Gynacophorus crassus.
    Cladocelium hepaticum Stossich 1892, see Fasciola hepatica.
    Distoma cavix Sonsino 1890, see Fasciola hepatica.
    celomaticum Giard and Billet 1892; body cavity.
    crassum Leidy 1891, see Fasciola magna.
    hepaticum Retzius 1786, see Fasciola hepatica.
    lanceolatum (Rud.) Mehlis 1825; biliary ducts.
    magnum Bassi 1875, see Fasciola magna.
    pancreaticum Janson 1893.
    texanicum Francis 1891, see Fasciola magna.
    Fasciola americana Hassall 1891, see F. magna.
    carnosa Hassall 1891, nec Rud. 1819, see F. magna.
    elaphi Gmelin 1789, see Amphistoma conicum.
    *hepatica L. 1758; biliary ducts.
    humana Gmelin 1789, see Fasciola hepatica.
    lanceolata Rud. 1803, see Distoma lanceolatum.
    *magna (Bassi) Stiles 1894; biliary ducts, intestine, and lungs.
    Festucaria cervi Zeder 1792, see Amphistoma conicum.
?Gastrothylax crumeniferum (Creplin) J. Poir. 1883; stomach.
    Gynacophorus crassus Sons. 1892; blood vessels, especially portal vein.
    Homalogaster Poirieri Giard and Billet 1892; large intestine.
    Monostoma conicum Zeder 1800, see Amphistoma conicum.

Cestodes.

Alyselminthus expansus de Blainv., see Moniezia expansa.
    denticulatus de Bl., see Moniezia denticulata.
    Coenurus cerebralis Rud.; larva of Taenia coenuurus.
    *Cysticercus bovis Cobb.; larva of Taenia saginata, in muscles.
    Taeniae mediohcanellatae Davaine, see C. bovis.
    Taeniae saginatae Leuck., see C. bovis.
    *tenuicollis Rud.; larva of Taenia marginata.
Echinococcus polymorphus Dies.; larva of Tænia echinococcus.

*Echinococcus polymorphus Dies.; larva of Tænia echinococcus.

Halyxis ovina Zeder 1803, see Moniezia expansa.

Moniezia alba (Perr.) R. Bl. 1891; intestine.

Benedeni (Mon.) R. Bl. 1891; small intestine.

dentculata (Rud.) R. Bl. 1891; fourth stomach and small intestine.

*expansa (Rud.) R. Bl. 1891; small intestine.

ovilla (Riv.) Mon. 1891, see Thysanosoma Giardi.

*planissima St. and H. 1893; small intestine.

?Stilesia centripunctata (Riv.) Raill. 1893; small intestine.

?globipunctata (Riv.) Raill. 1893; small intestine.

Tænia aculeata Perr. 1882, see Thysanosoma Giardi.

alba Perr. 1879, see Moniezia alba.

Benedeni Moniez 1879, see Moniezia Benedeni.

centripunctata Riv. 1874, see Stilesia centripunctata.

cœnurus Küchem. 1853, larva encysted in subcutaneous tissue,

brain, or spinal cord.

dentculata Mayer, see Moniezia expansa.

dentculata Rud. 1804, see Moniezia denticulata.

expansa Rud. 1810, see Moniezia expansa, also M. planissima.

echinococcus v. Sieb. 1853; larva encysted in various organs.

fimbriata Dies. 1850, see Thysanosoma actinoides.

Giardi Moniez 1879, see Thysanosoma Giardi.

globipunctata Riv. 1874, see Stilesia globipunctata.

marginata Batsch 1786; larva encysted in peritoneum, pleura, and

pericardium.

ovilla Riv. 1878, see Thysanosoma Giardi.

ovina Goeze 1872, see Moniezia expansa.

ovipunctata Riv. 1874, see Stilesia globipunctata.

*saginata Goeze 1872; larva encysted in muscles and viscera.

?Thysanosoma actinoides (Dies.) Stiles 1893; intestines, gall ducts, etc.

Giardi (Riv.) Stiles 1893; intestine.

Nematodes.

Ascaris sp. reported by Curtice; rare in small intestine.

Ascaris canis Schrank 1788, see Dioctophyme gigas.

?equorum Goeze 1872; intestine.

?lumbricoides L. 1758; intestine.

martis Schrank 1788, see Dioctophyme gigas.

megalocephala Cloquet 1824; see A. equorum.

renalis Gmelin 1879, see Dioctophyme gigas.

visceralis Gmelin 1879, see Dioctophyme gigas.

vituli Bruguière 1791, see Strongylus mierurus.

vituli Neumann 1883, see A. vitulorum.

vitulorum Goeze 1872; small intestine, also stomach.

Cheiracanthus hispidus Czokor 1882, see Gnathostoma hispidum.

Dioctophyme gigas (Rud.) Coll. Meyn. 1802; kidney.
Dochmius cernuus Baillet 1868, see Uncinaria cernua.

radiatus (Rud.), see Oesophagostoma inflatum.

Dracunculus medinensis Cobb. 1864, see Filaria medinensis.

Persarum Kämpfer 1694, see Filaria medinensis.

Eustrongylus gigas (Rud.) Diesing 1851, see Dioctophyme gigas.

visceralis Raill. 1885, see Dioctophyme gigas.

Filaria sp. Drechsler; capsules in intestinal wall.

bovis Baillet 1858, see F. lachrymalis.

bubali Rud., probably F. labiato-papillosa.

cervi elaphi Rud., see F. labiato-papillosa.

cervina Duj. 1845, see F. labiato-papillosa.

cincinnata Zürn 1872, see Spiroptera reticulata.

equina (Abildg.) Bl. 1849; body cavity.

labiato-papillosa Alessandrini 1838; peritoneal cavity.

lachrymalis Gurlt 1831; ducts of tear glands.

lienalis Stiles 1892, see Spiroptera reticulata.

medinensis (Velsch) Gmelin 1789; subcutaneous connective tissue.

palpebrarum Baillet 1858, see F. lachrymalis.

papillosa Rud. 1802, see F. labiato-papillosa.

reticulata Creplin 1846, see Spiroptera reticulata.

scutata Leuck. 1876, see Gongylonema scutatum.

terebra Dies. 1851, see F. labiato-papillosa.

tentaculata Mehlis 1846, probably F. labiato-papillosa.

Gnathostoma hispidum Fedtsh. 1873; stomach.

* Gongylonema scutatum (Müll.) Raill. 1892; epithelium of oesophagus.

pulchrum Molin 1857, perhaps G. scutatum.

Gordius viviparus Bloch 1782, see Strongylus micrurus.

Mastigodes affinis Zeder 1803, see Trichocephalus affinis.

Monodontus Wedlii Molin 1860, see Uncinaria cernuva.

Myzomimus scutatus Stiles 1892, see Gongylonema scutatum.

Nematodum sp. Leuckart; in capsules in lymph glands.

bovis tauri Diesing 1850; eye.

* Oesophagostoma columbianum Curtice 1890; nodules of intestinal wall.

* inflatum (Schn.) Raill. 1885; intestine, larvae in tumors.

Onchocerca reticulata Dies. 1841, see Spiroptera reticulata.

* Spiroptera cincinnata Ercolani 1865, see S. reticulata.

reticulata (Dies.) Raill. 1885; spleen.

scutata Leuck. 1876, see Gongylonema scutatum.

scutata oesophagea bovis Müller 1869, see Gongylonema scutatum.

Strongylus ammonis Rud. 1819, see S. contortus.

curticei Giles 1892; intestine.

cernuus Creplin 1829, see Uncinaria cernua.

contortus Rud. 1803; fourth stomach.

convolutus Ostertag 1890, nec Kuhn 1829, see S. Ostertagi.

dilatatus Raill. 1884, see Oesophagostoma inflatum.

fllicollis Molin 1860, nec Rud. 1803, see S. contortus.

filaria Rud. 1809; bronchi and bronchioli.
Strongylus gigas Rud. 1802, see Dioctophyme gigas.
inflatus Sehn. 1866, nec Molin 1860, see Oesophagostoma inflatum.

*micrurus Mehlis 1831, bronchi.
*Ostertagi (Ostertag) Stiles 1892; fourth stomach.

ovinus O. Fabr. 1784, see S. contortus.
pulmonalis Stiles' check-list, misprint for S. pulmonaris.
*pulmonaris Ercolani 1859; bronchi.

radiatus Rud. 1803, see Uncinaria radiata.

renalis Moq.-Tand. 1860, see Dioctophyme gigas.
*ventricosus Rud. 1809; small intestine.
vitulorum Rud. 1809, see S. micrurus.

Thelazia Rhodesii de Blainv. 1828, perhaps Filaria lachrymalis.

Trichina reticulata Dies. 1841, see Spiroptera reticulata.
spiralis Owen 1835; adult in small intestine, larva encysted especially in muscles.

*Trichocephalus affinis Rud. 1801; caecum.

ovis Abildg. 1795, see Tr. affinis.

*Uncinaria cernua (Creplin) Raill. 1885; intestine.
*radiata (Rud.) Raill. 1885; small intestine.
Vena medinensis Velsch 1679, see Filaria medinensis.

**Parasites of Sheep (Ovis aries L.).**

Trematodes.

Amphistoma conicum (Zeder.) Rud. 1809; first stomach.

Bilharzia bovis Sonsino 1876, see Gymancephorus crassus.
crassus Sonsino 1877, see Gymancephorus crassus.
Cladocelium hepaticum Stossich 1892, see Fasciola hepatica.
Distoma cavice Sonsino 1890, see Fasciola hepatica,
crassum Leidy 1891, see Fasciola magna.
hepaticum Retzius 1786, see Fasciola hepatica.
lanceolatum (Rud.) Mehlis 1825; biliary ducts.
texanicum Francia 1891, see Fasciola magna.
pancreatinum, probably error for D. lanceolatum.

Fasciola americana Hassall 1891, see F. magna.
carnosa Hassall 1891, nec Rud. 1819, see F. magna.
elaphi Gmelin 1789, see Amphistoma conicum.

*hepatica L. 1758; biliary ducts.
humana Gmelin 1789, see F. hepatica.
lanceolata Rud. 1803, see Distoma lanceolatum.
*magna (Bassi) Stiles 1894; biliary ducts.

Festucaria cervi Zeder 1792, see Amphistoma conicum.

Gymancephorus crassus Sons. 1892; blood vessels, especially portal vein.

Monostoma conicum Zeder 1800, see Amphistoma conicum.

Cestodes.

Alyseiminthus expansus de Blainv., see Moniezia expansa.

Coenurus cerebralis Rud., larva of Taenia coenurus.
Cysticercus oviparus Maddox.
  ovis Cobb. 1865, see C. tenuicollis.
  tenuicollis Rud., larva of Tænia marginata.
Echinococcus polymorphus Dies., larva of Tænia echinococcus.
Halyss ovina Zeder 1803, see Moniezia expansa.
Moniezia alba (Perr.) R. Bl. 1891; small intestine.
  Benedeni (Mon.) R. Bl., 1891; small intestine.
  ?denticulata (Rud.) R. Bl. 1891; intestines.
  *expansa (Rud.) R. Bl. 1891; small intestine.
  fimбриata (D.) Mon. 1891, see Thysanosoma actinoides.
  Neumann Mon. 1891; small intestine.
  *nullicollis (Mon.) R. Bl. 1891; intestine.
  ovilla (Riv.) Mon. 1891, see Thysanosoma Giardi.
  *planissima St. and H. 1893, small intestine.
  *trigonoıhora St. and H. 1893; intestine.
Stilesia globipunctata (Riv.) Raill. 1892; small intestine.
  centripunctata (Riv.) Raill. 1893; small intestine.
Tænia aculeata Perroncito 1882, see Thysanosoma Giardi.
  alba Perr. 1878, see Moniezia alba.
  Benedeni Moniez 1879, see Moniezia Benedeni.
  centripunctata Riv. 1874, see Stilesia centripunctata.
  cœnurus Küchenm. 1853; larva in brain and spinal cord.
  denticulata Mayer, see Moniezia expansa.
  echinococcus v. Sieb. 1853; larva encysted in various organs.
  expansa, see Moniezia expansa, M. planissima, or M. trigonoıhora.
  fimбриata Dies. 1850, see Thysanosoma actinoides.
  Giardi Mon. 1879, see Thysanosoma Giardi.
  globipunctata Riv. 1874, see Stilesia globipunctata.
  marginata Batsch 1786; larva encysted in omentum, liver, etc.
  ovilla Riv. 1878, nec Gmelin 1789, see Thysanosoma Giardi.
  ovina Goze 1782, see Moniezia expansa.
  ovipunctata Riv. 1874, see Stilesia globipunctata.
  tenella Cobb. 1865; supposed larva was Cysticercus tenuicollis.
  ?Vogti Moniez. 1879; small intestine.

**Thysanosoma actinoides** (Dies. 1834) Stiles 1893; duodenum and ducts of liver and pancreas.
  Giardi (Riv.) Stiles 1893.

Nematodes.

Ascaris sp. v. Drasche 1882; intestine.
  apri Gmelin 1789, see Strongylus paradoxus.
  flilocollis Rud. 1802, see Strongylus flilocollis.
  lumbricoides, see A. ovis.
  ?ovis M. C. V.; small intestine.
Dochmius cernuus Baille 1888, see Uncinaria cernua.
  hypostomus Dies. 1851, see Sclerostoma hypostomum.
Fusaria flilocollis Zeder 1803, see Strongylus flilocollis.
**Gonrylonema scutatum** (Müll.) Raill. 1892; wall of oesophagus.  
*scutatum* Raill. 1894; see *G. verrucosum*.  
*verrucosum* (Giles) Neumann 1895; stomach.  
**Gordius pulmonalis aprè** Ebel 1777; see *Strongylus paradoxus*.  
**Mastigodes affinis** Leder 1803; see *Trichocephalus affinis*.  
**Metastrongylus paradoxus** Molin 1860, see *Strongylus paradoxus*.  
**Myzomimus scutatus** Stiles 1892, see *Gonrylonema scutatum* (Müll.).  
**Monodontus Wedlii** Molin 1860, see *Uncinaria cernua*.  
**Nematodeum ovis** Rud. 1809; intestine.  
*ovis pulmonale* Dies. 1851, see *Strongylus rufescens*.  
**Nematodum sp.** Ebertz 1887; lung.  
**Œsophagostoma acutum** Molin 1860, see *O. venulosum*.  
*œsophagostoma cylindricum* Curtice 1890; colon, larvae in tumors in wall.  
*inflatum var. ovis* Caritè 1887, see *O. venulosum*.  
*venulosum* (Rud.) Raill. 1885; cæcum and colon.  
**Pseudalius ovis pulmonalis** A. Koch 1883, see *Strongylus rufescens*.  
*Pseudalius ovis pulmonalis* A. Koch 1883, see *Strongylus rufescens*.  
**Sclerostoma hypostomum** (Rud.) Duj. 1845; large intestine.  
Rhabdonema longum Grassi and Segrè 1887, see *Strongyloides longus*.  
**Spiroptera scutata** (Müll.) see *Gonrylonema scutatum* (Müll.).  
*verrucosa* Giles 1892, see *Gonrylonema verrucosum*.  
**Strongyloides longus** (Grassi and Segrè) Rovelli 1888; jejunum and ileum.  
**Strongylus ammonis** Rud. 1819, see *S. contortus*.  
*ceruus* Creplin 1829, see *Uncinaria cernua*.  
*colubriformis* Giles 1892, see *S. instabilis*.  
*contortus* Rud. 1803; fourth stomach.  
*Curlicaei* Giles 1892, see *S. ventricosus*.  
*convolutus* Ostertag 1890, nec Kuhn 1829, see *S. Ostertagi*.  
*elongatus* Duj. 1845, see *S. paradoxus*.  
*filaria* Rud. 1809; bronchi and bronchioli.  
*filicollis* Rud. 1803; small intestine or fourth stomach.  
*filicollis* Molin 1860, nec Rud. 1803, see *S. contortus*.  
*hypostomus* Rud. 1819, see *Sclerostoma hypostomum*.  
*instabilis* Raill. 1893; fourth stomach and duodenum.  
*longevaginatus* Dies. 1851, see *S. paradoxus*.  
*minutissimus* Mégnin 1878, see *S. rufescens*.  
*Ostertagi* Stiles 1892; fourth stomach.  
*ovinus* O. Fabr. 1784, see *S. contortus*.  
*ovinus* Fabr. 1788, see *Sclerostoma hypostomum*.  
*ovis pulmonalis* C. Curtice 1890, see *S. rufescens*.  
*paradoxus* Mehlis 1831; bronchi.  
*rufescens* Leuck. 1865; bronchioli and alveoli of lung.  
*suis* Rud. 1809, see *S. paradoxus*.  
*ventricosus* Rud. 1809; small intestine.  
*venulosus* Rud. 1809; see *Œsophagostoma venulosum*.  
? *vicarius* Stadelmann 1893; fourth stomach.  
**Trichina spiralis** Owen 1835; adult in small intestine, larvae encysted especially in the muscles.
*Trichocephalus affinis* Rud. 1801; cæcum.

_ucus Abildg. 1795, see *T. affinis*.

? *Trichosoma papillosum* Wedl 1859, nec Pol. 1860; intestine; perhaps larva of *Strongylus flicollis*.

*Uncinaria cernua* (Creplin) Raill. 1885; small intestine.

**Parasites of the Horse** (*Equus caballus* L.).

**Trematodes.**

_Amphistoma* sp. Cobb. 1879; stomach.

_Collinsi* Cobb. 1875; colon.

_Sonsinoi* Cobb. 1877, see *Gastrodiscus ægyptiacus*.

_Stanleyi* Cobb. 1875, see _A. Collinsi_.

_Cladoceltium hepaticum_ Stossich 1892, see *Fasciola hepatica*.

_Cotylegaster cochleariforme* v. Sieb. 1877, error—*Gastrodiscus ægyptiacus*.

_Diplostoma ægyptiacum* Cobb. and Sons. 1876, see *Gastrodiscus ægyptiacus*.

_Distoma crassum_ Leidy 1891, in part *Fasciola magna*.

_hepaticum_ Retzius 1786, see *Fasciola hepatica*.

_magnum_ Bassi 1875, see *Fasciola magna*.

_texanicum_ Francis 1891, see *Fasciola magna*.

_Fasciola americana_ Hassall 1891, see *F. magna*.

_carnosa_ Hassall 1891, nec Rud. 1819, see *F. magna*.

_hepatica_ L. 1758; biliary ducts.

_humana_ Gmelin 1789, see *F. hepatica*.

_magna_ (Bassi) Stiles 1894; biliary ducts.

_Gastrodiscus ægyptiacus* (Cobb. and Sons 1876); intestine.

_polymastos_ Leuck. 1880, see *G. ægyptiacus*.

_Sonsinoii* Cobb. 1877, see *G. ægyptiacus*.

_Hemistoma sp.? Sonsino 1876, see *Gastrodiscus ægyptiacus*. Monostoma Setteni Numan, probably larva of horse-fly (*Hypoderma*).

**Cestodes.**

_Alyshelminthus plicatus_ Zeder 1800, see *Anoplocephala plicata*.

*Anoplocephala mamillana* (Mehlis) R. Bl. 1891; jejunum or ileum.

*_perfoliata* (Goëze) E. Bl. 1848; cæcum or ileum.

*_plicata* (Zeder) R. Bl. 1891; small intestine, rarely stomach.

_Coenurus cerebralis_ Rud., larva of *Taenia coenurus*.

*_serialis_ Gervais 1845; larva of *Taenia serialis*.

_Cysticercus fistularis_ Rud., peritoneum; perhaps= *C. tenuicollis*.

_Echinococcus polymorphus_ Dies., larva of *Taenia echinococcus*.

_Taenia coenurus* (Küchenm.) 1853; larva encysted in eye, brain, or spinal cord.

_echinococcus_ v. Sieb. 1853; larva encysted in various organs.

_equina_ Pallas 1781, see *Anoplocephala plicata* and _A. perfoliata_.

_magnæ_ Abildg. 1789, see *Anoplocephala plicata*.

_mamillana_ Mehlis 1831, see *Anoplocephala mamillana*. 
NEMATODES.

Anguillula sp. Baillet 1882; dermal swellings.

*equorum* Goeze 1782; small intestine.

Ascaris canis Schrank 1788, see *Dioctophyme gigas*.

*equorum* Goeze 1782; small intestine.

Dermofilaria irritans Riv. 1884, see *Filaria irritans*.

Dioctophyme gigas (Rud.) Coll. Meyn. 1802; kidney.

Dioctophyme gigas (Rud.) CoII. Meyn. 1802; kidney.

Dioctophyme gigas (Rud.) Dies. 1851; see *Dioctophyme gigas*.

Dioctophyme gigas (Rud.) CoII. Meyn. 1802; kidney.

*equina* (Abild.) E. Bl. 1849; peritoneal cavity.

*equina* (Abild.) E. Bl. 1849; peritoneal cavity.

*equina* (Abild.) E. Bl. 1849; peritoneal cavity.

Equinococcus* vivipara* (Probstmayer) Raill. 1893; cæcum and colon.

Eusentromylus gigas (Rud.) Dies. 1851; see *Dioctophyme gigas*.

Filaria sp. Mégnin. 1878; subdermal connective tissue.

Filaria cincinnata Zürn 1872, see *Spiroptera reticulata*.

Filaria conjunctivae Addario 1885; eye.

Filaria palpebralis Pace 1867, nec Wilson 1844, perhaps *F. conjunctivae*.

Filaria palpebralis Pace 1867, nec Wilson 1844, perhaps *F. conjunctivae*.

Filaria papillosa Rud. 1802, see *F. equina*.

Filaria peritonrei hominis Babes 1880, see *F. conjunctivae*.

Filaria reticulata Creplin 1846, see *Spiroptera reticulata*.

Filaria sanguinis equi Sonsino; larva in blood vessels; perhaps young of *F. labiato-papillosa*.

Filaria scutata Leuck. 1876, see *Gongylonema scutatum*.

Anoplocephala perfoliata Duj. 1845, see *Anoplocephala perfoliata*.

Anoplocephala mamillana.

Anoplocephala plicata Rud., see *Anoplocephala plicata*.

Anoplocephala serialis Baillet 1863; larva encysted in viscera.
Gongylonema pulchrum Molin 1857, perhaps G. scutatum.

Gordius equinus (Müll.) Railliet 1892; epithelium of oesophagus.

Gordius viviparus Bloch 1782, see Strongylus micrurus.

Mastigodes equi Zeder 1803, see Oxyuris equi.

Myzomimus scutatus (Müll.) Stiles 1892, see Gongylonema scutatum.

Nematoideum equi caballi Peschel; wall of intestine; perhaps larva of Sclerostoma tetracanthum.

equi caballi Diesing 1850; wall of vessels.

Onchocerca reticulata Dies. 1841, see Spiroptera reticulata.

Oxyuris curvula Rud. 1803, see O. equi.

*equi (Schisto.) Bl. 1849; large intestine.

mastigodes Nitzsch 1866, see O. equi.

vivipara Probstm. 1865, see Anguillula vivipara.

Pelodera Axei Cobb. 1884; doubtful cause of disease known as “seedy-toe.”

P. equi reductata Schlotthauber 1859; caecum.

armatum, see Sclerostoma equinum.

Sclerostoma armatum Dies. 1851; see S. equinum.

*equinum (O. F. M.) de Blainv. 1828; caecum and colon; young in tumors and aneurisms.

hexacanthum Wedl 1856, see S. tetracanthum.

quadridentatum Duj. 1845, see S. tetracanthum.

robustum Giles 1892; caecum.

*tetracanthum (Mehlis) Dies. 1851; caecum and colon, young in tumors of wall.

Spiroptera cincinnata Ercolani 1865, see S. reticulata.

*megastoma Rud. 1819; in tumors of stomach.

megastoma var. major Dies. 1851, see S. microstoma.

?microstoma (Schn.) Zürn 1872; stomach.

reticulata (Dies.) Raill. 1885; in nodules in connective tissue.

scutata Leuck. 1876, see Gongylonema scutatum.

scutata cesophagea bovis Müller 1869, see Gongylonema scutatum.

Spirura megastoma Blanch. 1849, see Spiroptera megastoma.

Strongylus armatus Rud. 1803, see Sclerostoma equinum.

Arnfieldi Cobb. 1884; bronchi.

Axei Cobb. 1879; stomach.

asinitus Viborg 1795, see Sclerostoma equinum.

equinus O. F. M. 1784, see Sclerostoma equinum.

gigas Rud. 1802, see Dioctophyme gigas.

?micrurus Mehlis 1831; bronchi.

renalis Moq.–Tand. 1860, see Dioctophyme gigas.

tenuissimus Mazz. 1891, see S. axeii.

tetracanthus Mehlis 1831, see Sclerostoma tetracanthum.

vitulorum Rud. 1809, see S. micrurus,

Trichina reticulata Dies. 1841, see Spiroptera reticulata.

spiralis Owen 1835; adult in small intestine, larva encysted especially in muscles.
Parasites of the Dog (Canis familiaris).

**Trematodes.**

*Amphistomum truncatum* Rud. 1819, see *Distoma truncatum.*

*Distoma albidum* Braun 1893; biliary ducts.

*campanulatum* Ercolani 1874.

?*complanatum* Ercolani 1875, misprint for *D. campanulatum.*

?*conjunctum* Cobb. 1859; biliary ducts.

*conoideum* Raill. 1885, see *D. echinatum.*

*conus* Creplin 1825, see *D. truncatum.*

*conus* Gurlt 1831, see *D. felineum.*

*echinatum* Zeder 1803; duodenum.

*echiniferum* La Val. 1855, see *D. echinatum.*

*excavatum* Rud. 1819, see *D. echinatum.*

*felineum* Riv. 1884; biliary ducts.

*lanceolatum,* error for *D. truncatum* and *D. felineum.*

*militare* Rud. 1809, perhaps *D. echinatum.*

*pulmonale* K. S. and Y. 1881, see *D. Westermanni.*

*pulmonis* Raill. 1890, see *D. Westermanni.*

*Ringeri* Cobbold 1880, see *D. Westermanni.*

?*truncatum* (Rud. 1819); biliary ducts.

*Westermanni* Kerbert 1878; lungs.

*Hemistoma alatum* (Goeze) Dies. 1850; small intestine.

*Holostoma alatum* Nitzsch 1819, see *Hemistoma alatum.*

*Mesocogonimus Westermanni* (Kerb.) Raill. 1890, see *Distoma Westermanni.*

*Planaria alata* Goeze 1782, see *Hemistoma alatum.*

**Cestodes.**

*Bothriocephalus canis* Ercolani, probably *B. latus.*

*cordatus* Leuck. 1862; small intestine.

*dubius* Krabbe 1865, see *B. fuscus.*

*fuscus* Krabbe 1865; intestine.

*latus* Bremser 1819; small intestine.

*reticulatus* Krabbe 1865, see *B. fuscus.*

?*serratus* Diesing 1850; small intestine.

*Coenurus* sp. Pagenstecher 1877; larva of *Taenia* sp. found in subdermal tissue.

*Cysticercus Bailleti* Raill. 1885, see *Dithrydium elongatum.*

*cellulosae* Rud.; larva of *Taenia solium.*

*elongatus* Blumberg 1883, see F. Leuck. 1842, see *Dithrydium elongatum.*

*Dibothrium latum* Dies. 1850, see *Bothriocephalus latus.*

**Dipylidium caninum* (L.); end of small intestine.

*Dithrydium elongatum* Blumb.; larva of unknown tapeworm; body cavity.

*Echinococcus polymorphus* Dies.; larva of *Taenia echinococcus.*

*Mesocestoides lineatus* (Goeze); small intestine.
Piestocystis martis Dies. 1850, probably Dithrydium elongatum.

Taxi Dies. 1850, probably Dithrydium elongatum.

Plerocercoides Bailleti Raill., see Dithrydium elongatum.

Ptychophysa lineata Hamann 1885, see Mesocestoides lineatus.

Taenia canina L. 1767, see Batsch 1786, see Dipylidium caninum.

canis lagopodis Rud. 1810, see Mesocestoides lineatus.

?cecnurus Küchenm. 1853; in small intestine.

cucumerina Bloch 1782, see Dipylidium caninum.

cycticerci tenuicollis Leuck., see T. marginata.

*echinococcus v. Sieb. 1853; in beginning of small intestine; larva also encysted in various organs.

elliptica Batsch 1786, see Dipylidium caninum.

e cysticerco tenuicollis Küchenm. 1853, see T. marginata.

Krabbei Moniez 1879; in small intestine.

lata L. 1748, see Bothriocephalus latus.

lineata Göze 1782, see Mesocestoides lineatus.

litterata Batsch 1786, see Mesocestoides lineatus.

*marginata Batsch 1786; middle of small intestine.

moniliformis Pallas 1781, see Dipylidium caninum.

prima Plater 1603, see Bothriocephalus latus.

pseudo-cucumerina Baillet 1866, see Mesocestoides lineatus.

pseudo-elliptica Baillet 1866, see Mesocestoides lineatus.

*serialis Baillet 1863; in the small intestine.

*serrata Göze 1782; middle of small intestine.

solium (L.) Rud. 1810; larva encysted in muscles and viscera.

vulgaris L. 1748, see Bothriocephalus latus.

Nematodes.

Ascaris alata Bellingham 1839, see A. mystax.

canis Schrank 1788, see Dioctophyme gigas.

cati et caniculce Schrank 1788, see A. mystax.

felis Bruguère 1791, see A. mystax.

marginata Rud. 1802, see A. mystax.

**mystax Rud. 1802; small intestine and stomach.

renalis Gmelin 1789, see Dioctophyme gigas.

tricuspidata Bruguère 1791, see A. mystax.

vermicularis L. 1767, see Oxyuris vermicularis.

visceralis Gmelin 1789, see Dioctophyme gigas.

Werneri Rud. 1793, see A. mystax.

Ankylostoma caninum (Ercolani), see Uncinaria trigonocephala.

stenocephalum Raill. 1885, see Uncinaria stenocephalal.

trigonocephalum (Rud.), see Uncinaria trigonocephalal.

Calodium plica Duj. 1845, see Trichosoma plica.

Dioctophyme gigas (Rud.) Coll. Meyn. 1802; kidney, or peritoneal cavity.

Dochmius stenocephalum Raill. 1884, see Uncinaria stenocephalal.

trigonocephalal Duj. 1845, see Uncinaria trigonocephalal.

Balsami Grassi and Parona 1877, see Uncinaria trigonocephalal.

Dracunculus medinensis Cobb. 1864, see Filaria medinensis.

Persarum Kämpfer 1694, see Filaria medinensis.
*Eustrongylus gigas* (Rud.) Dies. 1851, see *Dioctophyme gigas.*

visceralis Raill. 1885, see *Dioctophyme gigas.*

Filaria acutiuscula Molin.

*canis* cordis Leidy 1850, see *F. immitis.*

hepatica Cobb. 1879; larva encysted on intestinal wall and liver; adult unknown.

*immitis* Leidy 1856; right cavity of heart; embryos in other blood vessels.

medinensis (Velsch) Gmelin 1789; subcutaneous connective tissue oculi canini Gescheidt 1833, see *F. trispinulosa.*

*Ostleri* Cobb. 1879; nodules on trachea and bronchi.

*Papillosa* hæmatica canis domestici Gruby and Delaf. 1852, see *F. immitis.*

recondita Grassi 1890; larva in blood.

sanguinolenta Schneid. 1866, see *Spiroptera sanguinolenta.*

trispinulosa Dies. 1851; eye; larva of unknown species.

Fusaria mystax Zeder 1800, see *Ascaris mystax.*

vermicularis Zeder 1803, see *Oxyuris vermicularis.*

Hæmatozyoon Lewis Grassi 1890; larva of *Filaria recondita.*

Lumbricus canis Werner 1782, see *Ascaris mystax.*

Mastigodes vulpis Zeder 1803, see *Trichocephalus depressiusculus.*

Nematoideum canis familiaris Warren 1830; oesophagus.

?Oxyuris vermicularis (L.) Bremser 1819; cæcum.

Sclerostoma caninum Ercolani 1859, see *Uncinia trigonocephala.*

*Spiroptera sanguinolenta* Rud. 1819; in tumors of stomach and oesophagus.

Strongylus canis bronchialis Osler 1879, see *Filaria Osleri.*

lupi Rud. 1809, see *Spiroptera sanguinolenta.*

*gigas* Rud. 1802, see *Dioctophyme gigas.*

renalis Moq.-Tand. 1860, see *Dioctophyme gigas.*

subulatus (Leisering) Cobb. 1879; in lung and veins.

trigonocephalus Rud. 1809, see *Uncinia trigonocephala.*

tetragonocephalus Rud. 1809, see *Uncinia trigonocephala.*

vasorum Baillet 1866; right heart and pulmonary artery, embryos in lung capillaries.

Trichina affinis Diesing.

*spiralis* Owen 1835; adult in small intestine, larva encysted especially in muscles.

*Trichocephalus depressiusculus* Rud. 1809; cæcum.

vulpis Fröölich 1789, see *T. depressiusculus.*

Trichosoma plica Rud. 1819; urinary bladder.

Uncinia stenocephala Raill. 1893; intestine.

*trigonocephala* (Rud.); small intestine.

vulpis Fröölich 1789, see *U. trigonocephala.*

Vena medinensis Velsch 1674, see *Filaria medinensis.*

Acanthocephala.

Echinorhynchus sp. Lewis; wall of stomach.

Grassi Deflke 1891.
Some few simple methods are necessary for the study of parasites. Those described here are the simplest which can be used and have no claim for completeness or for the needs of exact study; they are intended merely to aid those entirely unacquainted with such work.

1. Observation of Living Parasites.

From those which are encysted the cyst must first be removed by needles; care should be exercised not to tear the parasite. The process may be most easily carried out in a small dish of normal salt solution:

1 rounded teaspoonful of table salt,
1 quart of pure water.

More exactly 7 parts salt to 1000 parts water.

This solution also serves to wash those parasites which are covered with slime and refuse. It is better if warmed slightly, but under usual conditions parasites will live twenty-four hours or more in it.

After being cleaned parasites should be placed on a glass slide or slip and covered with a thin cover glass; they are then ready for examination with a lens or a compound microscope. All measurements should be made while the parasite is lying on a table, board, or on such a glass slide. By means of a thin rubber band flukes or tape-worms may be flattened out between two slides so as to become perfectly transparent. Special methods are referred to under particular topics.

2. To Kill and Preserve Parasites.

(a) They may be most easily killed after being washed in warm salt solution by placing them directly in 60 or 70 per cent alcohol. The amount of alcohol must be eight or ten times the bulk of the parasites. This method is rapid but does not yield such good results as

(b) Washing in salt solution and killing in a concentrated aqueous solution of corrosive sublimate to which a few drops of acetic acid have been added. The solution works best at about 125° to 135° F., and parasites should be left in it five to thirty minutes, according to size. The solution is poisonous; handle with care and use only wooden or horn instruments in it. Then wash in pure water one hour or more and place in 70 per cent alcohol. The specimens are then permanent, but should be enclosed in tightly corked bottles.

Staining parasites in carmine or other coloring matter, mounting and sectioning must be left for those who have had training in these particulars; it would not be possible to give the necessary instructions in this connection.

3. To send parasites.

(a) In the organs in which they occur or in bottles of salt solution they may be sent from adjacent places, but not from more than a short distance.

(b) Ordinarily they must be sent in alcohol. Follow the directions for washing and preserving given under 2. Small bottles may be sent by mail if tightly corked and securely packed in cotton or sawdust inside a wooden or tin cylinder or box and containing no writing save a label. Do not forget to send a letter explaining the matter by the same mail. Give your name and exact address. In case the specimens are too large to send by mail write about them, and await a reply.
Each parasite is listed in the index *only* under its correct name, which can be found by the use of the lists of parasites on pages 327 to 343 where all synonyms are included.

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